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Diverticulitis

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Preface

IT IS CUSTOMARY at the end of a preface for the author or authors to acknowledge their indebtedness to all those who assisted in the preparation of their book. Contrary to this custom I would like to acknowledge at once that Dr. Jordan was asked to write this monograph. Fortunately she had written a substantial part of it in which her personal views were presented before her untimely illness intervened. It was my rare privilege to be closely associated with Dr. Jordan for some years and to collaborate with her when it became evident that she could not finish this undertaking. Since then I have attempted to complete the volume her last contribution to medicine in accordance with her desires. I can only hope that the final product will meet with the approval of those who may choose to read it.

It was her opinion that by a critical review of the history of diverticulosis and diverticulitis a more complete understanding of this disease would be achieved. This review is followed by a discussion of the subject based on an unusually broad experience with colon disorders.

The diagnosis and treatment of diverticulosis and diverticulitis are discussed at some length with appropriate recognition given to their complications. The indications for surgical intervention are presented but details of surgical technique are omitted because it was believed they would be more appropriately covered in the surgical literature.

I want to acknowledge for Dr. Jordan and myself our grateful appreciation to Dr. Richard B. Cattell and Dr. Samuel F. Marshall of the Clinic staff who reviewed the final draft and offered constructive criticism to the Editorial and Photographic Departments for their helpful cooperation and to Dr. Melvin King who aided in compiling the bibliography. We are also indebted to the publishers

for their constructive suggestion and assistance in handling many of the details involved

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1 *Nomenclature*

The word *diverticulum* was first used by Cruveilhier² in 1849 to describe the small outpouching from the wall of a hollow organ which is now generally recognized as present singly or in numbers in the conditions known as diverticulosis and diverticulitis.

The Latin word *diverticulum* literally means a small diversion from the normal path. Perhaps no other medical word is so often used incorrectly in its suffix—the correct singular being the neuter *um* and the plural *a* whereas not infrequently the neuter plural is mistakenly used as a feminine singular and of it a feminine plural *diverticulae* is falsely contrived.

From the word *diverticulum* the derivative *diverticulosis* is used to describe the presence of such outpouchings and when there is inflammation in them the suffix *itis* indicating inflammation and infection replaces *osis* and forms the word *diverticulitis*. When such inflammation involves the structures surrounding the pouches it is called *peridiverticulitis*.

Where the words *diverticulosis* and *diverticulitis* are used without localizing the site of the abnormalities they are usually understood as referring to the colon where diverticula are most frequently found.

However diverticula are found though much less frequently in the esophagus as well as all parts of the gastrointestinal tract and in the urinary bladder and gallbladder.

2 *Historical Review*

Like the history of medical knowledge of many other diseases that of diverticulosis and of diverticulitis has considerable interest in that it shows the changing trends of thought in the past 50 years with regard to all aspects of these conditions. It seemed to the authors therefore that a review of some of the literature of more than a half century would throw an interesting light upon the whole subject of diverticulitis. There follows therefore in chronological series abstracts of some of the literature on this subject.

The etiology of the formation of the diverticulum has aroused much discussion especially in the early part of this century. Cruveilhier's pathologic description of this intestinal defect had been regarded with little interest until Craker³⁰ in 1899 wrote on a false diverticulum which he regarded as a hernial protrusion at a weak spot in the muscular layer of the colon produced by the entrance or exit of a blood vessel. He thought that such a protrusion constituting a diverticulum burrowed along the blood vessel sheath and was especially likely to occur if there were any obstructions to a free return of blood through inferior mesenteric veins as in valvular heart disease. This paper of Craker aroused interest in this condition to which very little attention had been paid since Cruveilhier's description 50 years previously.

1904

Beer¹⁰ in a paper entitled "Some Pathological and Clinical Aspects of Acquired (False) Diverticula of the Intestine" pointed out that the studies on the dead colon done by previous investigators Alek. Heschl, Hirsch, Good, Hirschmann, Fischer and Craker³² did not necessarily apply to the living colon and Beer particularly refuted the theory that weakness at the mesenteric border and at the point of entrance and exit of blood vessels was the basic reason for hernial protrusion. He quoted Chlumsky³⁷ who had performed

studies in the intestine of the living dog distending it to the point of rupture which was invariably on the nonmesenteric side of the gut a contrast to the studies on the intestine 10 hours after death when rupture occurred along the mesenteric border. He also referred to Sudsuki's work which in refutation of Graser's theory showed that only 6 of 15 cases of acquired diverticulitis showed a congenitive condition. Sudsuki¹⁰³ had still held however to the theory that diminished resistance at the points of entrance of blood vessels was responsible for the formation of diverticula. Beer however proposed the theory that old age and constipation better accounted for the formation of diverticula which occurred both on the nonmesenteric side of the gut where there are no points of entrance of blood vessels as well as along the mesenteric border.

1906

Moynihan^{81, 8} directed attention as did Graser to the difficulty in differentiating diverticulitis from carcinoma and reported 6 cases on which he had operated with a diagnosis of malignant disease before or at operation and in which subsequent histologic examinations showed false diverticula associated with inflammation.

In that same year Gordinier and Sampson⁴⁸ suggested that diverticula be looked for more frequently and that acquired diverticula of the small intestine occurred much more frequently than autopsy records showed and undoubtedly caused minor symptoms. He found them usually multiple arising at the site of vessel entry into the intestinal wall and sometimes involving the whole length of the small intestine whereas acquired diverticula of the colon were most frequently found in the sigmoid arising from any portion of the circumference of the bowel and of more clinical significance than those of the small bowel.

1907

The question of so called true and false diverticula was discussed by W. J. Mayo⁷⁶ and others who described the commonest and so called true variety as being that caused by traction of tumors or adherent organs while false diverticula were thought to be most

probably the result of excessive pressure from within the lumen of the bowel combined with a congenital weakness of the wall. The authors also called attention both to the frequency of occurrence of diverticula in the large bowel and to their tendency to extend into the epiploic appendage. As etiologic factors constipation with the impaction of hardened feces in the diverticulum was thought to be the important factor in the development of diverticulitis the irritation from the continued presence of the hardened feces resulting at times in ulceration. This theory in their opinion accounted for the fact that diverticulitis occurred most often in the sigmoid area of the colon. Mayo and others also observed that most persons with this disease were over 50 years of age and tended to be obese. They also noted that chronic passive congestion had been mentioned as a factor both in the production of diverticula and as a cause of diverticulitis. The authors also distinguished between diverticulitis and peridiverticulitis. In the former they described acute inflammation of the mucosa within the diverticula without reduction in size of the lumen and resultant obstruction but with a tendency to acute perforation into the peritoneal cavity. In peridiverticulitis they maintained that the submucosa was chronically inflamed around the diverticula and the bowel lumen reduced but perforation was rare because of the predominant reparative process. In 1907 when this paper was written 5 cases of chronic obstructive diverticulitis with resection of sigmoid were described.

1908

Abburst³ described a case which he assumed to be diverticulitis in a boy of 7 years 9 months. The boy had fever and a firm tender mass in the left lower quadrant. Exploration showed a tumor the size of a goose egg, with several associated large lymph nodes in the mesosigmoid. There was no obstruction and no resection was done. The patient recovered completely with gradual disappearance of the mass within a period of three and one half months.

Telling^{103 104 105} discussed the frequency of acquired diverticula in the large bowel especially the lower descending colon and sigmoid stating that they occurred chiefly in two rows either at the

sides of the gut or close to the mesenteric attachment but rarely on the convexity and most commonly into the appendices epiploicae. He stated that in the descending colon they were practically always filled with feces and noted that the aperture into the lumen was usually smaller than the maximum diameter of the diverticulum. He cited three possible explanations for the origin of diverticula: (1) that they are congenital and enlarge progressively during life; (2) that they arise from pathologic causes; and (3) that there is a congenital predisposition but that their formation depends on pathologic causes which operate during life. His own theory, with the balance of evidence at that time, was that there is a pathologic origin and that no congenital arrangement of muscle fibers producing a predisposition had been demonstrated. He considered the pathologic factors to include the narrow neck of the diverticulum, collections of fecal material within the diverticula, constipation, increased intraluminal pressure, and obesity. Telling also expressed the opinion that diverticula exist much more frequently than had been previously believed.

1910

Barbat⁶ cited a long list of 126 reports on the subject of diverticulitis; the majority from foreign literature summarized the theories of diverticula formation and etiologic factors in diverticulitis, discussed the complications, and the frequency with which this disease is confused with carcinoma and emphasized the high incidence of the disease and its complications.

Hartwell and Cecil¹¹ in a pathologic and clinical study noted that a diverticulum of the intestine had been recognized as a pathologic entity for over 100 years. They applied this term to any outgrowth of the intestinal wall, not neoplastic in character, which at some time had had a lumen connecting it with the intestine and whose walls are similar in structure to those of the intestine. With this definition, both Meckel's diverticulum as a congenital diverticulum and the vermiform appendix as a vestigial diverticulum can be included in this category of diverticula, but they considered it desirable to distinguish between congenital and acquired diverticula since no

probably the result of excessive pressure from within the lumen of the bowel combined with a congenital weakness of the wall. The authors also called attention both to the frequency of occurrence of diverticula in the large bowel and to their tendency to extend into the epiploical appendages. As etiologic factors constipation with the impaction of hardened feces in the diverticulum was thought to be the important factor in the development of diverticulitis, the irritation from the continued presence of these hardened feces resulting at times in ulceration. This theory in their opinion accounted for the fact that diverticulitis occurred most often in the sigmoid area of the colon. Mayo and others also observed that most persons with this disease were over 50 years of age and tended to be obese. They also noted that chronic passive congestion had been mentioned as a factor both in the production of diverticula and as a cause of diverticulitis. The authors also distinguished between diverticulitis and peridiverticulitis. In the former they described acute inflammation of the mucosa within the diverticula without reduction in size of the lumen and resultant obstruction but with a tendency to acute perforation into the peritoneal cavity. In peridiverticulitis they maintained that the submucosa was chronically inflamed around the diverticula and the bowel lumen reduced but perforation was rare because of the predominant reparative process. In 1907 when this paper was written 5 cases of chronic obstructive diverticulitis with resection of sigmoid were described.

1908

Ashhurst³ described a case which he assumed to be diverticulitis in a boy of 7 years 9 months. The boy had fever and a firm tender mass in the left lower quadrant. Exploration showed a tumor the size of a goose egg with several associated large lymph nodes in the mesosigmoid. There was no obstruction and no resection was done. The patient recovered completely with gradual disappearance of the mass within a period of three and one half months.

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more to congenital weakness of the circumferential muscularis than to any other factor and constipation seems the important element in their development. He also believed that low grade proliferative changes take place in the tips of the diverticula forming segregated epithelium similar in all respects to the cell changes which occur in the masses of epithelium segregated about the base of a gastric ulcer. From such epithelial proliferation which fills the entire diverticulum he conjectured that infiltration of its wall developed forming an histologic picture which must be diagnosed as carcinoma.

1912

The first case of cecal diverticulitis was described by Potier.⁶⁸ McGrath⁷⁷ wrote on the etiology and pathogenesis of intestinal diverticula. He described the formation of the diverticulum as a herniation of the mucosa through the muscularis in the region of the vessels usually rupturing into the vessels. He observed that the herniated structures usually involve the mucosal and submucosal coats. He noted as conditions important in considering the development of diverticula obesity, cachexia, loss of intraabdominal fat in previously obese individuals, areas of weakness in an otherwise normal intestine, intraintestinal pressure, proximity of diverticula to points of entrance of blood vessels into the intestinal wall, location of epiploic appendage, infection involving lymph channels, long blood vessel wall, muscular deficiency, congenital weakness of muscularis, constipation, and old age. He like Mayo⁷¹ distinguished between diverticulitis and peridiverticulitis and he thought that cancer was associated with diverticulitis having observed it in 25 per cent of his series.

1914

Bunts¹⁸ called attention to a case of formation of a truly false diverticulum or herniation of the cecum at the site of prior appendiceal surgery where the protrusion appeared to have taken place through a ring formed by the purse-string suture. In this case the patient had recurrent attacks of right lower quadrant pain which disappeared after surgical correction.

proof of either could be obtained except in the case of Meckel's diverticulum and the vermiform appendix. These authors referred to the false diverticulum as not having all the structures found in the normal wall while the true diverticulum contains all these structures but they believed that the true might become the false by the loss of some of these structures. They noted that diverticula had been found in every portion of the alimentary tract from the pylorus to the anal ring there having been reported diverticula even in the appendix itself. They recorded however that the sigmoid was the favorite site and that in the rectum proper it was rare. They observed that small intestinal diverticula occurred between the mesenteric leaves or close to them but that in the colon they were often placed laterally. In their opinion the primary cause could not be determined but the existence of a congenital defect in the musculature was probable and contributing causes were most likely old age constipation and obesity. They referred however to Ashhurst's report of the occurrence of diverticula in children and to other reports in individuals under 30 years. They stated that while the diverticulum itself is harmless changes may occur which are similar to those occurring in the vermiform appendix. They described these changes as Mayo had previously done inflammation with or without perforation abscess generalized peritonitis septicemia fistula formation into another hollow viscus especially the urinary bladder. They mentioned also the possibility of chronic subacute inflammation with recurrent attacks of acute diverticulitis and they also described changes in the entire intestinal wall and its mesentery with or without obstruction resulting from the narrowing of the lumen or secondary to adhesions. For the first time in their paper they mentioned the possibility of a superimposed carcinoma. Included in their paper were 13 case reports of which 2 from autopsy material were in children age 6 and 10 years.

1911

Wilson¹¹⁸ formulated a theory of the development of carcinoma from diverticula. In his opinion diverticula while they frequently follow the course of blood vessel probably owe their origin

plete obstruction in diverticulitis) (4) the group in which carcinoma develops in a diverticulum leading to the conclusion that when a tumor appears as diverticulitis and without acute symptoms in the colon and a chronic mass persists with less severe symptoms carcinoma should be suspected and resection performed

1924

Judd and Pollock⁶³ wrote on diverticulitis of the colon presenting various observations of interest They considered that it may be a static condition remaining unchanged for years and often not causing symptoms or it may progress to abscess formation fistulas or free perforation They had not observed it in any other part of the colon except the sigmoid They also mentioned the difficulty of distinguishing diverticulitis from carcinoma of sigmoid and stated that in their group of 137 cases there appeared to be no relationship between the two thus being the first to suggest that the theory of Wilson and others that carcinoma arose from diverticulitis was probably incorrect and that their occasional coexistence was coincidental It was their opinion that many patients with diverticulitis can be successfully treated medically surgery being indicated for perforation abscess formation and inability to diagnose the nature of a tumor formation They also suggested preliminary colotomy for obstruction and for the purpose of reducing inflammation by frequent irrigations of the lower colon and later lessened surgical risk These authors regarded proctoscopy as of little value unless the lesion was actually visualized

1929

Greensfelder and Hiller⁶⁴ wrote about cecal diverticulosis which in their opinion should be suspected if symptoms resembling appendicitis occurred in a patient who had had previous appendectomy Cecal diverticula may be either primary with etiology similar to that of sigmoid diverticulosis and occurring frequently in younger individuals or it may be secondary to traumata resulting from an operative procedure in the right lower quadrant The authors reported that in 5395 major operations and 400 adult necropsies

1915

Case ¹ was one of the first to draw attention to the x ray demonstration of diverticula and their complications and in the same year Carman ^{19 0} joined the x ray pioneers with two papers on cases of diverticulitis and their x ray findings pointing out that left sided appendicitis could be excluded by the finding of a normal position of the cecum. He also discussed the difficulties of differential diagnosis of diverticulitis from carcinoma, indicating that the presence of barium filled diverticula would tend to indicate diverticulitis. He also suggested the taking of films in different views in order to pick up the extraluminal shadows of diverticula.

1917

Mayo ⁷⁵ wrote on *diverticulitis of the large intestine* reporting 42 cases which had had surgical treatment since the disease had first been recognized. Of the 37 involved the sigmoid 1 the transverse colon 1 the ascending colon 1 the hepatic flexure and cecum and 2 the rectum. The patients ranged in age from 27 to 73 and there were twice as many females as males. He mentioned its clinical similarity to appendiceal inflammation except that the symptoms were usually on the left and in 34 cases a tender mass in the left lower quadrant was present. In 13 cases (31 per cent) carcinoma coexisted with diverticulitis and the author considered this was more than a coincidence and that chronic irritation and inflammation of the diverticula led eventually to cancerous change. He classified diverticulitis into four groups: (1) self limiting diverticulitis and peridiverticulitis usually occurring in the middle aged and obese and usually recurrent (This group was in his opinion a poor risk for surgery which should only be considered if symptoms were serious or chronic relapsing) (2) the group with abscesses and fistulas where conservative surgery should be employed (3) the group with obstruction where it is difficult to distinguish diverticulitis from carcinoma (The author here offers two differentiating points: (a) a long history of symptoms in diverticulitis (b) complete obstruction frequent in carcinoma as contrasted with incom

Small doses of mineral oil and an anti constipation diet are prescribed the dietary regimen being highly essential With complications they thought surgery should be done but it was accompanied by a high mortality rate The authors recommended as an operation of choice a graded procedure consisting of drainage and subsequent resection and anastomosis Often prolonged drainage alone produced recession of tumefactions and disappearance of clinical symptoms rendering further intervention unnecessary The pathologic changes in diverticulitis occurred probably because of stasis of the fecal stream in this portion of the colon with formed stool preventing emptying of the diverticulum when it was packed with feces They thought that local inflammatory changes then began in the mucous membrane of the diverticulum which became atrophied There was round cell infiltration of the submucous coat and later ulceration With progressive change of this type in the bowel wall and the mesentery itself symptoms of inflammation and obstruction occurred with perisigmoiditis and mesenteritis The changes in the coats of the diverticulum varied from attenuation of the musculature to its complete absence when the wall was made up only of mucosa and serosa The mesentery and its attachment became thickened and contracted with considerable tumefaction While free perforation was rare localized perforation with abscess and fistula was not uncommon

1933

Wilkinson¹¹⁷ wrote a paper on diverticulitis in which he referred to the fact that Friend noted diverticula of the large bowel as early as 1730 more than a century before Cruveilhier's pathologic description of them Wilkinson also referred to Klebs' papers in 1869 which first directed attention to the relation of diverticula to the point in the bowel wall at which blood vessels traverse it Wilkinson also credited Graser with arousing interest in 1899 in the entity of diverticulosis following a long period after Cruveilhier's description in which nothing had been written about it Wilkinson discounted the value of differentiation of true and false diverticula He mentioned the lack of symptoms until inflammation occurred mani-

performed at the Michael Reese Hospital there were 1 case of traumatic solitary cecal diverticula 2 at operation and 2 at autopsy They considered their etiology to be either eversion of cecum between two constricting adhesive bands or traction of a narrow adhesion or eversion at the stump site as a result of weakness due to migration of a silk purse string suture into the cecum or following the rupture of a stump abscess into the bowel lumen

1930

Rankin and Brown²² writing about diverticulitis stated that diverticulosis occurred probably in about 1 per cent of all persons and in about 5 per cent of patients with symptoms referable to the large bowel Of those individuals with diverticulosis they estimated that about 17 per cent had diverticulitis in most cases chronic with exacerbations Concerning etiology the authors tend to agree with Beer that the chief factor is inherent weakness of the muscle wall abetted by obesity and constipation and that diverticulitis is probably the result of improper emptying of bottle shaped sacculations with subsequent inflammatory reaction necrosis and occasional perforation In 227 cases reviewed in their paper a malignant condition was associated with diverticulitis in only 1 case and in 679 cases of carcinoma of the colon only 4 cases of diverticulosis were found The authors believed that diverticulitis occurred almost entirely in persons of middle age and inclined to be corpulent and leading sedentary lives They believed it usually ran a chronic course with exacerbations and yielded satisfactorily to medical treatment They noted that the outstanding symptom was pain in the left lower abdomen frequently associated with constipation They thought that while bleeding was not usually associated with diverticulitis it might occur giving rise to a suspicion of a malignant lesion which was frequently not found Bleeding usually arose in the opinion of the authors from the anal canal They considered tumefaction the result of inflammatory reactions commonly associated with diverticulitis Medical treatment recommended by the authors consisted of bed rest irrigations of the affected segment with warm saline solution and watchful waiting

around the wall of the bowel. The pouches are separated by ridgelike elevations.

(5) Diverticula can actually be seen more often than is usually believed especially in the absence of inflammation. Buie cautions that the polyp in an unusual location should be recognized.

1943

Five years later than when Buie first wrote about the proctoscopic findings another paper was written by Jackman and Buie⁶⁰ on proctoscopic aid in the diagnosis and differential diagnosis of diverticula. The records of 242 patients who had had both proctoscopic and x-ray studies of the colon were studied. Of these 160 cases (66 per cent) showed evidence of diverticulitis by proctoscopic examination; in 35 cases diverticula were visualized and in an additional 72 cases sigmoidal sacculations as described in Buie's paper of 1939 were described. In the other 53 cases such findings as immobility, sharp angulation, reduced lumen, also previously described by Buie, strongly suggested the presence of diverticula of the sigmoid and in all these cases the proctologic findings were confirmed by x-ray. The authors also reported 74 per cent successful diagnostic results in 50 cases in which colostomy had to be performed as an emergency measure for obstruction in the lower bowel. The proctoscopy was performed either through the colonic stoma or the anus.

1944

Young and Young¹¹ in a paper on diverticulitis of the colon emphasized the relative frequency of the disease, the errors in diagnosis, and the too high morbidity and mortality. They compiled statistics showing an incidence of 5.2 per cent diverticulosis in 70,572 colons examined by barium examination in the living and by autopsy. They estimated that 12 to 15 per cent of the developed diverticulitis, but in three reported series totaling 3,915 cases with diverticulosis of the colon the incidence of diverticulitis was 34.3 per cent. The statistics showed 22 per cent to have been

fested by abdominal pain usually in the left lower quadrant or periumbilical fever constipation with intermittent diarrhea and a palpable mass in the left lower quadrant For the first time hemorrhage was described as a complication He emphasized the importance of x ray diagnosis for diverticulosis and of clinical and x ray findings for diverticulitis in which condition x ray showed diverticula in proximity to a constant irregularity and narrowing of the lumen of the gut He also mentioned the fact that clinically, roentgenologically and even at surgical exploration the differentiation between diverticulitis and a malignant lesion might be very difficult In the treatment of both diverticulosis to prevent diverticulitis and of diverticulitis itself he advised against the use of laxatives and enemas since these were likely to force more material and bacteria into the diverticula He recommended the attempt to keep stools normally formed and to prevent overactive peristalsis and increased intraluminal pressure He suggested for the treatment of diverticulitis bed rest the avoidance of purgatives laxatives and even mineral oil the use of tincture of belladonna and of an easily digestible diet with warm fluids He considered surgery necessary only for complications

1939

Buie¹⁴ introduced the possibility of diagnosis of sigmoidal diverticulosis and diverticulitis by five proctoscopic signs

(1) There is limited mobility of a segment of bowel which is normally freely movable This immobility is not confined to the rectum as is the case when there is pelvic disease or a fixed retroverted uterus

(2) There is a sharp turn of the bowel where it is immobilized by diverticulitis with difficulty in or impossibility of passing the proctoscope beyond the angulation

(3) There is a mucosa showing adherent folds and a contraction of the lumen The mucosa may also be edematous

(4) Where there is no inflammation and the sigmoid is mobile shallow sacculations may be seen extending partially or wholly

1940 and 1942 believed that diverticula developed essentially as a result of a combination of physical forces with weakening or spreading of the circular muscular layer at the points of entrance of its blood vessels due to intracolonic pressure from constipation muscular spasm or other causes. Another view held by Fansler⁴² was that in middle age degenerative changes occurred in the muscle layer followed by traumatization from hard stools and gas distention but that this damage did not necessarily occur at the points of vascular penetration. Schlotthauer also referred to Wierda's⁴¹ belief that diet was a factor since in 3 rats fed on a high fat diet he found diverticulosis of the colon. Schlotthauer also cited a fourth theory that for the formation of a diverticulum there had to be a congenital anatomic deficiency in the wall of the colon which acted as the starting point since diverticulosis occurred sometimes in young people before the age at which degenerative changes take place. For support of this theory he quotes Poate³⁷ Lynch⁴⁰ Erdmann⁸ 40 41 Badia⁵ Bearce⁸ 9 and Cave⁴ 5. Such cases as Schlotthauer presents in this paper could be explained on this basis. He reported colon diverticulosis present in 7 brothers of one white family consisting of 7 males and 2 females the ages ranging from 49 to 70 years and their habits of living social status occupations place of abode size and weight varying greatly. In this instance it would be difficult to ignore heredity as a factor in etiology.

Morton⁴⁰ writing on diverticulitis of the colon called attention to the fact that this disease is of interest to internists surgeons pathologists gynecologists and urologists. He restated Case's definition of diverticulosis as the finding of diverticula in a routine radiographic picture of the large bowel representing no significant pathology and no symptomatology and occurring in 5 per cent of post mortem examinations of individuals of 40 years and over at the Mayo Clinic. Morton's study was comprised of 111 cases of diverticulitis with spasm and 85 cases with multiple complications. In the group of 111 cases with spasm the patient was typically middle aged or older obese habitually constipated and sedentary. Clinically there was often lower abdominal pain with sudden onset and with constipation often preceded by several loose stools. Distention

operated upon. In one series 15 per cent presented complications requiring surgery. These authors thought the incidence was slightly greater in men than in women and that only about 0.3 per cent occurred below the age of 30. They also reported 5 to 17 per cent of bleeding in diverticulitis with rare massive bleeding. They recommended prophylactic treatment when diverticulosis was diagnosed such treatment consisting of low roughage diet, mineral oil to promote regular elimination, the avoidance of all irritable cathartics and enemas, and the use of tincture of belladonna. In all respects except in the use of mineral oil the measures coincided with those recommended by Wilkinson 11 years previously. In like manner the suggestions offered for the treatment of diverticulitis agreed with those of Wilkinson. The authors recommended surgery for acute perforation, obstruction, fistula formation, localized abscess and suspicion of cancer. In an analysis of 84 cases at the Faulkner Hospital in Jamaica Plain, Massachusetts, 86 per cent were over 10 years old, the youngest being 37. The sexes were about equally divided. Blood was found in the stools in 26 per cent of cases in which no other cause for blood was found and the incidence of blood was greater in chronic diverticulitis (33 per cent) than in acute diverticulitis (20 per cent). The most common complaints in acute diverticulitis were of abdominal pain (usually in the left lower quadrant) and elevation of temperature and leukocytosis. In the chronic form of diverticulitis 79 per cent of the cases in this study had abdominal pain with symptoms of indigestion especially gas distress and nausea. These authors found positive sigmoidoscopic findings: spasm, immobility, sharp angulation and mucosal edema in 71 per cent of their cases, but no actual diverticular sacs were visualized.

1946

Schlotthauer²⁶ presented a report of 7 cases of diverticulosis in one family of 9 persons. He discussed the current thought on etiology, defining it as a herniation of the mucosa and submucosa of the intestine through a defect in its circular muscular layer. He referred to Ceballos²⁶, Dixon²⁷ and Edwards²⁸ who in the years

colon which had been involved by diverticulitis. Morton also suggests a conservative treatment consisting of bed rest, simple diet, antispasmodics, heat to the abdomen and sedation. He believed antibiotics were unnecessary. Surgery in his opinion should be reserved for complications.

1949

Carlson and Hoelzel¹⁸ reported investigations on rats which revealed that diverticula were found in areas contiguous to lobulated fat deposits and that abnormally high intracolonic pressure was a causative agent in the development of diverticula in the colon. It was thought by these workers that the bowel wall was weakened as a result of fat infiltration and that herniation of this weakened part of the wall occurred into a fat infiltrated peritoneal sacculation. When a concentrated low residue diet was fed the rats there was a continuous contraction and increased intracolonic pressure whereas this did not occur when the diet was bulky.

1951

Fwell⁴ wrote on a complication of diverticulitis the intestino-vesical fistula. He stated that about 50 per cent of all intestino-vesical fistulas were due to diverticulitis of the colon and consequently all individuals with diverticulitis of the colon were potential candidates for this complication which like any fistula secondary to inflammatory disease almost always developed after a localized abscess formation and was usually a tortuous tract. For the diagnosis of this condition the history of pneumaturia or the passage of feces through the urethra were usually considered pathognomonic of intestino-vesical fistulas. The author stated that this was true of passage of feces but pneumaturia might be due to other causes as well. Passage of urine through the rectum although uncommon was another cardinal symptom of intestino-vesical fistula. The physical examination should be supplemented by cystoscopy, excretory urography, cystograms, gastrointestinal x-ray and proctosigmoidoscopy. With cystoscopy the opening might be visualized or bubbles of gas or fecal matter be seen extruding into the bladder. A barium enema revealed the fistula.

nausea vomiting fever occasionally chills tenesmus and bladder symptoms might follow the onset of pain. Tenderness and a palpable mass in the left lower quadrant together with elevated temperature pulse rate and white cells were the chief diagnostic signs. Only 2 of these 111 cases were under 30 years of age and both sexes were about equally represented. In addition to the usual pain in the lower abdomen constipation diarrhea distention and vomiting blood was found in 32 cases (bright red in 24 cases and tarry stools in 8 cases). If 10 of these cases in which other possible causes for blood were found were eliminated from this group there was still an incidence of 20 per cent reasonably ascribable to diverticulitis. When no complications were present the author believed that the disease was self limited and improved or subsided in three to seven days under medical care during which time the surgeon must exercise restraint.

In the 85 cases with complications perforation occurred in 39 cases fistula in 22 cases obstruction in 34 cases cancer in 17 cases some having multiple complications. In the group of 39 cases with perforation 3 had perforated into the peritoneal cavity with resulting peritonitis. In the other 36 there were localized abscesses and the symptoms previously described for diverticulitis were increased in intensity. Of this group 10 died in the hospital. In the 22 cases with fistula the abscess of perforation had opened or made its way into a neighboring organ to the skin in 11 cases into the bladder in 8 cases the urethra in 2 cases the small intestine in 2 cases the cecum in 1 case the rectum in 2 cases the vagina in 1 case retroperitoneal tissues in 1 case to form an ischiorectal sinus in 1 case and a sinus into the mesocolon in 1 case. In 11 of these cases the fistulas were multiple. In the 34 cases of diverticulitis with obstruction due to infiltration of the intestinal wall there had been repeated infections and scarring and thickening of the colon causing gradual occlusion of the lumen. There were no other possibilities to be considered for the cause of obstruction chiefly adhesions around an abscess cavity and adherence of the small intestine to an acutely infected diverticulum. In the 17 cases where cancer was associated with diverticulosis only four of the cancers were in the area of the

the lesion was a cancer even with a completely annular tumor. These authors recommended the occasional use of a double contrast enema for identification of the lesion. They also recommended as helpful features in the differential diagnosis of diverticulitis and carcinoma: (1) greater length of area of involvement in sigmoid diverticulitis than in carcinoma; (2) much better preservation of the mucosal contours in diverticulitis; (3) more complete obstruction (increased by spasm) in diverticulitis; (4) if a mass was present usually tenderness in diverticulitis; (5) abrupt transition from relatively normal to abnormal bowel in carcinoma with cuffing, overhanging edges or shelving often visualized.

Swinton¹⁰⁴ wrote on the surgical aspects of diverticulitis, stating that the policy of the Lahey Clinic had been to operate on patients with diverticulitis only if complications had developed, conservative treatment being adequate for the majority of uncomplicated cases of diverticulitis. This author also mentioned the possible occurrence of an acute exacerbation from the use of castor oil or other laxative in preparation for roentgenographic or sigmoidoscopic examinations. His indications for surgical intervention were: (1) evidence of acute perforation; (2) abscess formation; (3) obstruction; (4) inability to exclude diagnosis of a malignant tumor; (5) fistulae; (6) repeated hemorrhages; (7) failure to obtain relief by conservative measures. His choice of surgical procedures was: (1) for acute perforation, simple closure of the perforation with a proximal diversion colostomy when indicated as in an extensive process or when obstruction is suspected; (2) for abscess formation, incision and drainage followed by resection of the diseased process after the acute process subsided; (3) for obstruction, a three stage procedure: a right transverse Mikulicz type of colostomy, resection of the tumor and later closure of colostomy. If malignant disease could not be excluded in the presence of an obstructing tumor, he recommended segmental resection of the involved area and, if possible, examination of the removed tissue before a final decision was made as to the operative procedure to be used. For enterocolic or other fistula, he considered a three stage procedure indicated: a preliminary right transverse colostomy followed in four to six months

in about 20 per cent of cases due to diverticulitis. The injection of methylene blue solution into the bladder or rectum might be observed for its passage from one to the other which was a conclusive finding. Surgery was usually successful and recurrences were rare. One stage operations were possible since the use of sulfonamides and antibiotics but in some cases these drugs have masked symptoms of diverticulitis and thus have allowed the development of a fistula from a dormant abscess when the fistula could have been prevented with earlier surgery. A two stage operation was indicated in this author's opinion when excessive induration and inflammation were present.

Wigh and Swenson¹¹⁸ wrote on the roentgenologic aspects of diverticulitis and its complications. They stated that the generally accepted incidence of diverticulosis was 5 to 10 per cent and of these 12 to 22 per cent developed diverticulitis at some time. Peridiverticular abscesses were identified in two ways (1) by a palpable mass contiguous with or displacing the bowel fluoroscopically (2) by their recognition as abscesses on the roentgenograms because their opening into the lumen of a diverticulum was sufficiently large to permit the ingress of opaque mixture. These authors stated that fistulas were a fairly common complication of diverticulitis (10 to 15 per cent of all cases of diverticulitis that had surgery also had bladder fistulas according to Bockus). Fifty per cent of vesicocolic fistulas from inflammatory lesions resulted from diverticulitis and these constituted twice the number of those due to carcinoma. When no diverticula were visualized carcinoma had to be considered as the origin of the fistulous tract.

While localized inflammatory processes usually subsided and a normal bowel was restored repeated attacks of inflammation caused a thickening of the bowel wall and reduction in the size of the lumen with possible obstruction. The authors estimate that two thirds of the cases of diverticulitis had their complaints based on obstruction. They also made the observation that with the barium enema spasm was produced giving an appearance of greater obstruction than was demonstrated when the barium passed distally. This was often only transitory spasm and was not usually seen when

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by resection of the diseased sigmoid with primary anastomosis closure of the bladder defect and a later third stage closure of the colostomy

Smith²⁷ discussed the theories of etiology with regard to constipation and he considered it a factor but while constipation is more common in females than in males diverticula is occurred more frequently in males. He mentioned the theory of Devine and Devine³⁴ who stated that straining at stool was a contributory factor yet while the expulsive effect was more marked in the rectum than in the sigmoid diverticula appeared more often in the sigmoid and fecal material was firmer in the rectum than in the sigmoid. The theory that increased intraluminal pressure caused the pulsion type of diverticula could be contested in his opinion by the fact that although these positive pressure relationships were present from birth diverticula occurred chiefly in later life. He referred to Yeomans¹⁰ four possible reasons for the development of diverticula (1) hernial protrusion following emerging veins (2) increased intraluminal pressure causing herniation through weak points as a result of irregular contraction (theory of Keith) (3) In final analysis it was a matter of weakness existing for some cause in the intestinal coats because of which a pouching of the coats occurred when undue pressure arose as suggested by Hartwell and Cecil (4) It was Erdmann's opinion that *all were of congenital origin and no single factor could explain all diverticula*. Smith also discussed the place of sigmoidoscopy in diagnosis as having increasing value with experience and reviewed Buie and Jackman's findings. Smith also noted that the presence of diverticula is sometimes disclosed during sigmoidoscopy by displacement of their fecal content as a result of slight pressure from the distal tip of the sigmoidoscope. He had observed the diameters of the orifices to vary from several millimeters to 2 centimeters. Rarely an inverted diverticulum would resemble a polyp by sigmoidoscopic examination. When diverticulitis was present sigmoidoscopic diagnosis became more difficult and there was no typical picture it often being impossible to rule out carcinoma. A long history suggesting gradually increasing ob-

struction the presence of edema the lack of bleeding and the occurrence of more pain than was usual in the presence of carcinoma might suggest that the underlying process was diverticulitis. Smith also mentioned the fact that a previous hysterectomy endometriosis and uterine myomas might give the false impression that fixation was secondary to diverticulitis.

Albright and Leonard¹ wrote on the management of diverticulitis coli. In general they believed that preventable bowel invalidism serious surgical complications and fatalities from diverticulitis might sometimes be avoided by good management including the establishment of a simple effective bowel management regimen maintenance of an adequate anal outlet and proper election and timing of surgical intervention. In the authors' opinion more emphasis should be placed on the role of spastic constipation and anal back pressure in perpetuating symptomatic diverticulitis and initiating complications. Bed rest bland low residue diet avoidance of cold fluids antispasmodics sedation heat to abdomen and hot water to drink with the avoidance of cathartics were recommended. Anal spasm or fibrosis may require anal dilatation under anesthesia external sphincterotomy or the operative correction of associated anal disorder. The authors also emphasized the fact that with recent surgical advance resection in symptomatic cases can be done in selected patients. They used a proximal diverting colostomy before resection and stated that colostomy closure without resection failed in over two thirds of cases in which it was done. While pre-resection bowel preparation for a week is adequate in carcinoma a first stage fecal diversion for several months is better in inflammatory diverticulitis. They also believed that resection by exteriorization was usually safer than primary resection unless the segment involved was short the inflammation chronic or slight and distal obstruction was absent.

1952

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sive attitude should be taken i.e. primary resection rather than the defunctioning of the bowel for a period of several months before resection is done a form of treatment often advised for diverticulitis. These authors found only 62 definite cases of coexisting carcinoma and diverticulitis of the colon in the literature up to May 1950. They also reviewed the historical data on diverticulosis and diverticulitis mentioning the description in *Bullius Anatomy* in 1794. They called attention to Virchow's¹¹¹ description of isolated circumscribed adhesive peritonitis of the colon. Virchow failed however to associate this lesion with diverticula which he had described. The authors stated that Graser⁴⁹ in 1898 was the first to consider the inflammatory stenosis of the sigmoid and rectum as simulating carcinoma of the colon while Beer in 1904 raised the question of predisposition of the inflamed bowel to the development of carcinoma. Following Wilson's paper various authors already reviewed in this book perpetuated the theory that diverticulitis predisposed to carcinomatous development. However Rowe and Kollmar believed that since 1924 sufficient statistical evidence had shown that the occurrence of carcinoma and diverticulitis was merely coincidence. Their survey of several hospitals showed that among 700 patients with carcinoma of the colon only 7 had coexisting diverticulitis and carcinoma and these authors made the point that only 3 (0.43 per cent) had carcinoma and diverticulitis in the same segment. The authors stated that a strong suspicion of cancer is justified only if weight loss and bleeding with obstruction and anemia are present while a palpable mass and fistula formation are more suggestive of diverticulitis. They stated that bleeding occurs with both diverticulitis and diverticulosis in variously reported incidence (5 to 26 per cent) but that an exhaustive search for other origin should always be made. In addition to proctoscopy as a helpful diagnostic aid occasionally cytologic studies with the Papanicolaou technic are helpful but precise x-ray examination is still the most accurate method of diagnosis. These authors also recommend the more frequent use of primary resections and anastomoses to care for possible carcinoma and to decrease surgical morbidity.

1953

Case and Shea¹ wrote on acute diverticulitis of the cecum. They stated that all inflammatory diseases of the cecum are rarely diagnosed correctly even at operation where diverticula may be buried in a mass of inflamed edematous tissue and thought to be neoplastic and therefore requiring unnecessarily radical surgery. They reviewed 7 cases (17 per cent) of cecal diverticula at St. Vincent's Hospital. They discussed the etiology, dividing them into true and false type, considering that some are congenital and represent persistence of an early embryologic appendix. They quoted Greensfelder and Heller concerning the other mechanical etiologic factors but they stated that most solitary cecal diverticula are congenital true diverticula with all the muscle layers represented in their walls. Since signs and symptoms are usually identical with those of acute appendicitis, acute diverticulitis can usually be diagnosed only at operation. In the chronic form, radiography is useful but here too it may be difficult to distinguish from carcinoma, tuberculosis of the cecum, actinomycosis of the bowel, or nonspecific ulcers of the cecum, many of which the authors believed may be the end result of necrotic processes in a diverticulum of the cecum. Regional ileitis with extension to the cecum and amebic ulcer of the cecum must also be differentiated. The authors reported 4 cases of cecal diverticulitis, in 2 of which the complications of perforation, abscess formation and fistula formation were present.

Starkloff and Bindbeutel¹⁰⁰ discussed the differential diagnosis of diverticulitis and carcinoma of the colon and presented a study of 259 cases of carcinoma of the colon and 30 cases of diverticulitis. Of the 25 patients had coexisting carcinoma and diverticulosis of the same segment, the rectosigmoid, and 6 had coexisting carcinoma and diverticulitis, 4 of whom had the coexisting lesions in the same segment (15 per cent). This figure agrees with other previous statistics and emphasizes that the relationship is coincidental. In 5 cases, however, the clinical diagnosis of diverticulitis proved to be incorrect, the lesion being carcinoma without diverticula. In their conclusions they emphasized the fact that no reliance can be

placed on symptoms and signs except for bleeding and cachexia which should arouse suspicion of carcinoma *In their series bleeding was present in 62 per cent of carcinoma and 19 per cent of diverticulitis* X ray examination with reliance on a normal appearance above and below the malignant growth is subject to pitfalls The authors advised a more radical surgical approach especially if carcinoma is strongly suspected

Lewis and Hurwitz⁶⁸ wrote on surgical treatment of sigmoid diverticulitis reporting 10 consecutive cases of severe and complicated diverticulitis of the sigmoid with resection of the diseased segment and end to end anastomosis without mortality Six patients did not require previous or complementary diverting colostomy while 4 had an earlier diverting colostomy all of which were closed later These authors laid down principles for the treatment of three complications For acute perforation they recommended incision and drainage closure of perforation and a proximal diverting colostomy with later closure for obstruction a proximal diverting colostomy was also necessary with resection of the diseased segment and redundant sigmoid in three to six weeks following the preliminary procedure (These authors believed that intraperitoneal closure of the colostomy should be done after the integrity of the suture line has been demonstrated which usually is the case in approximately three weeks) for fistulas they use a diverting colostomy early resection of the colon with excision of fistulas and later closure of colostomy In their opinion a more aggressive surgical approach is necessary because of the morbidity and mortality associated with this disease ■ diverticulitis

Vaughn and Narsete^{109, 110} wrote on the rare form of diverticulitis that of the ascending colon They stated that up to 1953 only 14 cases of diverticulitis of the ascending colon had been reported to which they added 2 of their own Of the previously reported cases most had been in patients between 10 and 40 years old whereas of their 2 cases 1 occurred in a 50 year old man and the other in a 67 year old woman and in both cases the atypical finding of melena was present One patient had diarrhea and melena for four days occurring two months and again one week before admission There

was bright blood by rectum but the patient also had hemorrhoids. The other patient had left subcostal pain intermittently for two years and melena for two weeks. The diagnosis of these lesions is made by the use of barium enema examination with serial exposure. Treatment of the disease is usually surgical because acute appendicitis cannot be ruled out. In 14 cases previously reported their location varied 6 being medial 6 lateral and 2 anterior. The syndrome of this condition simulates appendicitis but when diverticula are located in the ascending colon the appendix is less likely to be involved than when they are in the cecum. The incidence of all diverticula of the large bowel is according to these authors 3 to 7 per cent and of these only 1.5 to 2 per cent occur in the right half of the colon. These authors estimate that in about 15 per cent the bowel becomes inflamed. The causative factors of diverticula in the right colon have not been accurately determined but the following should be considered:

- 1 Eteorosis is commonest in ileocecal areas
- 2 Hereditary factor not possible of proof
- 3 Evidence of a weakened bowel wall
- 4 Traction on the appendix by pleural metastatic involvement by intestinal abdominal disease
- 5 Weakening of the bowel wall by aacular entry
- 6 Increased intraluminal pressure
- 7 Cathartics and purgatives
- 8 Mucosal ulcerations

In previously reported cases the ratio of females to males was 2 to 1 whereas in diverticula of the cecum itself it was about equal. Diverticula of the ascending colon had a greater tendency to occur in the younger age group when compared with cecal diverticula.

Another paper on right colon diverticulitis was written by Unger¹⁰⁸ who reported 6 cases. He stated that 132 cases had already been reported in the literature. Clinically it is indistinguishable from acute appendicitis. In Unger's cases the age range was from 26 to 64 years and sex distribution equal. In all cases acute diverticulitis was suspected. Diverticulectomy complemented by appendectomy if feasible is the operation of choice but when cecal neoplasia cannot be excluded ileocolic resection is justified. Wherever

experience attended this operation and serious complications can thus be prevented

How and Bernhard ⁷ wrote about the complication of bleeding in diverticular disease. They stated that this complication had received little attention. They considered as still not conclusively proved the theory of pathogenesis which assumes that the outpouching of the mucosa occurs through the muscle layers at the point of emergence of a nutrient artery to an appendix epiploica. They reported on the incidence of rectal bleeding in 317 cases from a 10 year period at the Peter Bent Brigham Hospital in which the bleeding originated from diverticulosis or diverticulitis. An additional 38 cases of diverticula and concomitant carcinoma were also reviewed. There were 111 patients with diverticulitis. 42 (37 per cent) had rectal bleeding. 31 of whom had no gross evidence of rectal bleeding or melena but had two or more positive stools for occult blood. Nine patients had a history and gross evidence of bleeding or the stool was strongly positive to the guaiac test. Two patients had uncontrolled rectal hemorrhage and required surgical treatment as a life saving procedure. Of the 12 cases 11 had associated obstruction and 1 had abscess formation. The other 30 had no major complication. The data showed that bleeding *per se* associated with diverticulitis has no significant relationship to other complications except obstruction. Of the total group of 385 cases a carcinoma was present in an area of diverticulitis in only 14 (3.6 per cent). As a correlating study the authors reported that of 466 cases of carcinoma of the colon and rectum over a 10 year period a concomitant x-ray diagnosis of diverticulosis was made in 38 cases (8 per cent) which is approximately the expected figure in the middle or old age group of the entire population. The authors reported 4 cases of massive hemorrhage with diverticular disease. 3 of the 4 patients died which led the authors to recommend early operation provided other sources of bleeding are eliminated. ulcerative colitis is absent by proctoscopy and diverticula are present by x-ray examination. The authors stated that while cancer of the colon is the commonest cause of rectal bleeding it is relatively uncommon as a cause of massive hemor

rhage Of 236 case of diverticulo is (without carcinoma) detectable rectal bleeding was present in 39 or 16 per cent

Higgins and Burger ⁶ wrote on an uncommon form of diverticulosis and diverticulitis that of the vermiform appendix stating that it occurs in about 1 of every 200 appendices and may be congenital with all layers of the bowel intact or acquired with no muscularis layer Edel ³⁷ in 1894 described the c appendiceal diverticula and since then there has been considerable discrepancy in the reported incidence and some controversy over the classification and pathogenesis These diverticula are often overlooked at surgery and the diagnosis is made only by the pathologist They are not an extension of diverticulosis of the colon The authors reported a case of retrocecal appendix with five diverticula projecting from the antimesenteric border one acutely inflamed and perforated

Colcock and Sass ^{9 31} wrote on the occurrence and complications of diverticulitis in the aged They stated that the highest incidence of this disease occurs in the sixth or seventh decade of life and that it is more common in overweight patients with sedentary occupations who suffer from constipation Therefore it should be suspected in any patient over 40 years of age who is overweight and complains of repeated attacks of left lower quadrant distress They mentioned the possibility of occlusion from inflammatory reaction in the bowel and called attention to the fact the dysuria should be considered a warning that the inflammatory process may be involving the bladder wall They regarded rectal bleeding as an unimportant symptom of diverticulitis and suggested the need for searching for other sources of bleeding if this is present They mentioned the fact that the x ray finding of a rather long area of narrowing suggests diverticulitis rather than cancer in which the narrowed area is shorter They also mentioned the picket fence or saw tooth appearance of the mucosa which is usually seen throughout the involved area in contrast to its absence in malignant lesions Also in diverticulitis the area is more tender and rigid when palpated during fluoroscopy and the so called *hipping* is absent In a review of 50 case of carcinoma and 50 cases of diverticulitis the complications of perforation and abscess and fistula occurred much more

often in diverticulitis (40 per cent and 31 per cent) than in carcinoma (6 per cent and 2 per cent) obstruction likewise was present more often in diverticulitis (22 per cent) than in carcinoma (16 per cent) They believed that most cases of diverticulitis can be adequately managed by conservative treatment but about 10 to 20 per cent of these patients will have repeated attacks or complications They recommended surgical treatment for recurrent or extensive diverticulitis to avoid complications which they believed are especially hazardous in old patients In such cases they thought the best operation is a proximal transverse colostomy followed in several months by resection and anastomosis and finally by closure of the colostomy but if carcinoma is suspected resection must be done in two to three weeks with further procedures depending upon the pathologic findings

1955

Friesen and Schmidt ⁴⁶ reviewed 301 cases in which the diagnosis of diverticulosis or diverticulitis had been made Of these 7 per cent required surgery with stenosing obstruction as the chief indication The authors mentioned the fact that antibiotics have decreased the incidence of abscess and fistula formation The choice of surgical procedure depended on many factors such as the age and general condition of the patient the acuteness of the process the presence or absence and degree of obstruction the number and duration of previous attacks the extent of inflammatory reaction the presence of fistula or abscess and the mobility and accessibility of the involved segment

Gilchrist and Economou ⁴⁷ wrote on surgical treatment of diverticulitis of the colon They stated that one third of persons over 15 have diverticula of the colon most commonly in the sigmoid next frequently in the descending colon but at times scattered throughout the colon They also stated that diverticula are not seen below the peritoneal reflection and in their opinion they are pulsion diverticula Increased intraluminal pressure is an influence on their formation is indicated by the fact that in case of carcinoma of the sigmoid with obstruction diverticula nearest the obstruction are

deeper and more inflamed than the more distant ones. The authors believed also that inflammation associated with the diverticula may be the actual cause of fixation in carcinoma of the sigmoid which makes the prognosis better in the cases. Abscesses are formed by the trapping of feces in the diverticulum. Their indications for surgery are the usual ones: (1) free perforation which may occur in a rather movable portion of the sigmoid; (2) abscess formation; (3) partial or complete obstruction; (4) fistula formation; (5) inability to exclude carcinoma; (6) recurrent disability and pain. These authors also discuss the problem of bleeding in the presence of diverticulitis, stating that it must be assumed that polyps or carcinoma are also present and even if they are not definitely found the involved portion of the colon should be removed and the rest of the colon explored. When surgery is performed and the descending colon as well as the sigmoid is involved both should be removed thus excising most of the diseased bowel and promoting loose stool resulting in less danger from remaining diverticula.

McMillan and Jamieson⁷⁸ wrote on trends in surgical treatment of diverticulitis of the colon. They considered the five complications of diverticulitis to be (1) perforation; (2) obstruction; (3) fistula formation; (4) carcinoma; and (5) bleeding. They considered the small slowly developing and walled off perforation as possibly subsiding but frequently recurring. A right transverse colostomy with incision and drainage of abscess is indicated if medical management is unsuccessful. They also thought that acute perforation into the peritoneal cavity is more common than usually believed and requires drainage and colostomy. For obstruction they believed that failure to use prompt surgical treatment leads to disastrous results when obstruction is caused by fibrotic, edematous or granulomatous stenosis or distention of the colon in which cases intubation, enemas and antibiotics are unsuccessful. They regarded treatment of external or internal fistulas without resection of the diseased colon as discouraging. They also stated that inability to distinguish carcinoma from diverticulitis is one of the most definite indications for resection. They also found that bleeding is often severe enough to warrant operation. They expressed the opinion

that diverticulitis may be *disabling and hazardous if not consistently controlled by a good medical program*. They considered the disease more severe in patients under 50 years of age and that resection is indicated while the patient is in good general condition. Unexplained urinary symptoms and severe residual deformity of the sigmoid are in their opinion indications for surgery. The surgical measures discussed by them are (1) cecostomy which they consider frequently inadequate and unsatisfactory as a definitive or preliminary operation (2) colostomy as a necessarily palliative or preliminary operation in patients in poor condition (but they regarded closure of the colostomy without resection as frequently resulting in further exacerbation or complication of the disease). The best operation is in their opinion resection with anastomosis which may be done in two or three stages depending upon the condition of the patient. This can usually be accomplished safely in three to four weeks and be followed in another three or four weeks by closure of the colostomy.

Judd and Mears⁶ wrote on the surgical progress toward a wider application of a single stage resection of diverticulitis of the sigmoid. They believed that in the past surgery has been used only in cases with complications and that from experience a multiple stage operation was considered necessary. They thought that this approach should be reevaluated and that a prophylactic resection of the colon during a quiescent interval of the disease has much to recommend it. Under these circumstances a single stage primary resection can be done with very low morbidity and very little risk because of modern improvements in anesthesia and advances in antibiotic therapy and preoperative and postoperative care. They recommended this elective surgery in patients with a history of recurrent attacks of diverticulitis even though the patient is in apparent good health and x-rays show only scattered diverticula the purpose of such surgery being to spare the patient the increased risk, discomfort, inconvenience and expense of multiple stage procedures when serious complications are present. They emphasized the indications of such elective surgery not only for patients with recurrent attacks *in spite of good medical care* but also for all patients with

urinary symptoms associated with an attack of diverticulitis (usually male patients) and when carcinoma cannot be ruled out. In their experience 11 of 68 patients had hemorrhage which could not be attributed to any other cause.

1956

Bacon and Valiente⁴ wrote on the surgical management of diverticulitis. They emphasized the greater need for preventive resection particularly because of the low mortality and morbidity now possible through control of colic bacterial flora, improved nutritional control and electrolyte replacement. Preventive resection can usually be done in one stage with *conservative preoperative* treatment in cases of acute diverticulitis, delaying the operation until the acute infection has subsided. If a liberal segment of bowel is resected by left hemicolectomy and anastomosis of the distal transverse colon to the low sigmoid or rectosigmoid, rehabilitation of the patient is excellent in most cases. Even when the policy of preventive resection is used there will still be special problems arising from the fact that diverticulitis is often first diagnosed when a complication occurs. For acute sudden perforation of the colon the authors recommended repair of the site of rupture with or without transverse colostomy. When the bowel wall is friable, local repair cannot be done and exteriorization is the best treatment, but if the bowel cannot be readily mobilized the inflammatory area is drained and transverse colostomy is performed with Neomycin solution (5 Gm in 500 ml of sterile solution) directly injected into the bowel lumen and flushed through the colon by gentle manipulation. Fistulas are treated by resection of the diseased segment and removal of the fistulous tract and the viscus penetrated by the fistula is repaired. A three-stage procedure is chosen if there is preoperative evidence of active infection and inflammation with three weeks to three months elapsing between colostomy and resection. Strictured areas, if inflammatory reaction is minimal, are best treated with primary resection because of the high incidence of carcinoma in diverticulitis. Hemorrhage which is usually severe and accompanied by shock can be treated conservatively but the patient must be prepared for resection when

Zininger¹ stated that patients with chronic low grade obstruction and recurrent low grade inflammation should have the benefit of surgical excision. This operation is in his opinion often more difficult than in cases of neoplasm since the mesentery is often thickened shortened and fibrotic and the ureter is drawn up into it necessitating accurate dissection of the ureter before any resection of the mesentery. With acute infection or significant obstruction preliminary diverting colostomy is done before resection is attempted and in acute perforation local drainage plus colostomy should be performed to be followed by whatever surgical measures are appropriate. Simultaneous presence of diverticula or diverticulitis and carcinoma is in this author's opinion reasonably common and differentiation often very difficult particularly when inflammation and at least some degree of obstruction are present. A diverting colostomy is usually a necessary preliminary operation and the time between colostomy and resection is usually four to six weeks with modern methods of surgery.

Allen and Behringer reported on 210 consecutive patients treated by resection since 1942, 27.6 per cent of whom were admitted and operated on after their first attack of diverticulitis. These authors stated that about two thirds of persons aged 85 have diverticulosis and one third have diverticulitis sufficiently severe to warrant surgical treatment. They also stated that it is their conviction that radical treatment is more logical in the young than in the old since one of the serious complications is more likely to develop during the longer life of the younger patient. Furthermore in the younger age group before serious complications occur a one stage operation can be readily done. Nearly all patients of any age however can be treated by resection if the definitive procedure is properly planned. With longstanding diverticulitis and chronic obstruction a well planned resection at an elective time usually gives safe relief.

Waugh and Walt¹¹ writing on changing concepts in the treatment of diverticulitis of the sigmoid stated that about 80 per cent of patients should be able to avoid operation for diverticulitis but when the disease does not respond to medical measures as one

stage operation can usually be done in a quiet period. While a preliminary transverse colostomy will always be necessary in some patients and in others a proximal colostomy at the time of anastomosis may be life saving, colostomy is no longer regarded as a routine concomitant of the surgical treatment of this disease. The authors considered the main indications for elective operation today to be (1) intractability and recurrent episodes, (2) subacute obstruction, (3) walled off perforation which responds temporarily to antibiotics and non-surgical treatment, (4) unexplained melena with x-ray evidence of diverticulitis, (5) fistula formation between sigmoid and other organs including kidney, (6) recurrent or persistent urinary symptoms caused by the diverticulitis, and (7) inability to diagnose nature of a palpable mass (diverticulitis or carcinoma).

Maynard and Voorhees¹⁰ wrote on a case of arterial hemorrhage from a large bowel diverticulum.

1957

Keith and Rini¹¹ described the significance of diverticula of the colon in massive melena. They noted that clinicians and pathologists are reluctant to accept diverticula as the source of hemorrhage because at autopsy a bleeding point may be difficult to find. The incidence of diverticulosis of the colon is estimated at 5 to 10 per cent of adults over 40 years of age, hence hemorrhage if due to diverticula should be a fairly frequent occurrence. To attribute melena to diverticula, however, certain criteria should be recognized, namely the bleeding should be of bright red blood, there should be no hematemesis, all other sources of bleeding should be eliminated, there should be a negative upper gastrointestinal x-ray series, and blood coagulation should be normal. In the authors' survey of 317 unselected patients with diverticula of the colon, 60 (19 per cent) had massive hemorrhage, gross bleeding or stools repeatedly positive for occult blood by the guaiac test. Nineteen (6 per cent) had massive rectal bleeding, and of this group 13 patients had syncope or subjective symptoms of shock. In all cases conservative management with replacement of blood was used. The authors advised against emergency surgery in most cases, and in

many cases in which diverticula are distributed over most of the colon surgical resection is inadvisable because the specific bleeding site is seldom located. However if the diverticula are limited to the left colon *resection should be feasible and when they are distributed over the entire colon a transverse colostomy may suffice to afford relief of bleeding*.

Knight⁶⁷ wrote on massive hemorrhage from diverticular disease of the colon stating that hemorrhage as a complication of such disease of the colon is a fairly well accepted concept. Not as well recognized however is the occurrence of massive exsanguinating hemorrhage as a complication of this disease. This author reported from the literature a varying incidence of bleeding from 10 to 30 per cent usually of minimal amounts. Knight reported two series of patients: (1) 185 patients seen over a 10 year span with proved diagnosis of diverticulosis or diverticulitis and (2) 104 cases seen over a six year period also with proved diagnosis of diverticulosis or diverticulitis. In group one 23 of the 185 patients (12.4 per cent) gave a history of gross bleeding from the rectum. Adequate studies in all these cases showed no other cause for bleeding. 7 of these 23 cases had evidence of marked blood loss requiring blood replacement. In group two 33 (31.7 per cent) of the 104 patients gave a history of gross bleeding presumed to be from diverticular disease there being no other cause found and x-ray evidence of diverticulosis present. Of these patients 10 showed disease involving almost the entire colon. In 1 case proctoscopic examination disclosed bleeding from the mouth of a diverticulum in the sigmoid. Of the 33 patients 7 suffered massive bleeding requiring blood replacement. Of these 7 4 had diverticulosis of the entire colon and 3 showed diverticula from the hepatic flexure to the rectum. The author drew several inferences from this study. He considered massive bleeding a relatively rare occurrence considering the frequency of diverticulosis. He believed from his study that the severity of the bleeding seemed to be correlated to the extent of the diverticular formation but he did not discount the possibility of hazardous bleeding from localized diverticulosis. He also called attention to data observed in his study showing that massive hemorrhage seems more

likely to arise from diverticulo is rather than from diverticulitis and that infection is not essential for hemorrhage to occur. No patients in this series had signs or symptoms of diverticulitis at the time of hemorrhage or a history of it in the past. His thesis therefore is that local trauma produce ulceration with subsequent hemorrhage and is therefore the most important etiologic factor in hemorrhage from this disease. Knight suggested conservative treatment at first that is rest, splanchnic bowel management and blood replacement as indicated. In most cases even in those with considerable bleeding he found this adequate. An elective resection of the diseased bowel seem justified in localized diverticulosis when bleeding is recurrent or severe. The challenge comes when massive bleeding does not stop and emergency laparotomy is required. In such cases bleeding can be controlled by resection if the disease is localized. If the disease is extensive involving the entire colon it is not always possible to localize the bleeding area, resect it and do a subtotal resection of most of the bowel since an emergency operation for exsanguinating hemorrhage is a formidable procedure. The author treated 2 patients of this type with diversion of the fecal stream by means of a colostomy and hemorrhage was thereby controlled. He therefore suggested this procedure with a possible elective resection at a later time as the safest way to control massive hemorrhage from this cause.

Strenger¹ felt that diverticulitis is a chronic progressive disease and advocated early surgical intervention before the onset of complications. His criteria for election of patients for surgery were as follows: (1) a definite history of diverticulitis supported by physical findings in the lower quadrant of the abdomen; (2) roentgenograms showing diverticula and persistent deformity and spasm of the sigmoid indicative of an inflammatory process; (3) a specific history of more than one attack; (4) rectal bleeding attributed to diverticulitis; and (5) a good surgical risk.

1958

Boles and Jordan¹² reported a study of 294 patients with diverticulosis whose history through an average follow up of 15 years (minimum of 10 years) was investigated for (1) increase in

number of diverticula (2) the development of diverticulitis in single or recurrent attacks and (3) development of complications bleeding obstruction perforation with or without fistula formation. More extensive diverticulosis developed in about one half of the total group with one third finally having involvement of the entire colon. Diverticulitis developed in 25 per cent (73 patients). Of this group over one half (40 patients) had no second attack (follow up of three to 15 years). Of the 33 with multiple attacks about one half (16) had only two attacks. The only complication of diverticulitis which appeared to be related to multiplicity of attacks was obstruction (9 out of 11 patients with obstruction having had multiple attacks). Melena or a brisk hemorrhage occurred in 18 of the total group (6 per cent) and of the 18 cases 9 had simple diverticulosis with no evidence of diverticulitis. Of the total group 15 patients (5 per cent) had large bowel obstruction (2 with associated small bowel involvement) but only 11 of this group with obstruction had a clinical picture of diverticulitis. Of the total group 15 (5 per cent) had perforation with or without fistula formation. 10 of this group presented this complication during an acute attack of diverticulitis while in the other 5 cases perforations were slowly developing with mass or fistula formation. In 15 (5 per cent) of the 29½ patients with diverticulosis carcinoma appeared during the follow up period. 8 (3.6 per cent) of these in the group of 221 patients who had had no attacks of diverticulitis. In the 73 patients who had had diverticulitis carcinoma appeared in 7 (9.6 per cent) but 2 of these 7 patients had carcinoma in an area of the colon where no diverticula were present and 2 others had carcinomatous polyps of the sigmoid. In only 3 patients (4 per cent) carcinoma appeared in the area of the colon where previous diverticulitis had occurred.

Horner wrote on 503 patients whom he followed 15½ from six to 10 years and none less than one year in an attempt to elucidate facts on the natural history of the disease. He believed that aging definitely plays a role in development but that previous bowel habit had no etiologic role. However 83 per cent had an irritable colon prior to the development of the diverticula. Approximately two

third showed no progression in the number of diverticula and 95 per cent had sigmoidal involvement. The longer the follow up the better chance there was for the complication of diverticulitis to become manifest. He believed that diverticulosis is a benign condition responding well to medical management. Only 2 of the 85 patients with diverticulitis required surgical intervention and interestingly the complication of obstruction did not develop in any patient in this group.

Schapira et al.²³ recommended conservative and nonoperative treatment for diverticulitis of the cecum and right colon. In their experience a second attack was quite rare. They believed diverticula of the cecum and right colon are the same type as those in the left colon but usually they are fewer and more difficult to demonstrate especially during the acute phase.

Degenshein²⁵ however believed that the diverticula of the right colon are pathologically distinct from those of the left in that they are true diverticula containing all coats. The clinical diagnosis of diverticulitis is based on pain in the right lower quadrant with a mass and absence of nausea and vomiting. He recommended for treatment the more radical approach of primary right hemicolectomy.

Welch¹¹³ noted the pattern of attacks of diverticulitis to be so variable that it was impossible to be dogmatic with regard to indications for surgery. In the individual patients these considerations were important: (1) other more malignant symptoms present such as rectal bleeding or dysuria; (2) roentgenographic studies showing serious deformity of the involved segment of the colon indicating that fibrosis and severe structural change will lead to obstruction at a later date; (3) the attacks being persistent despite compliance with good medical advice and troublesome enough to require relief; (4) those patients younger than 50 years representative of a group who will have the disease longer and who appear clinically to have a disproportionate number of serious complications; and (5) the patient representing a good operative risk with a limited segment of colon involved with diverticulitis.

He believed that the changing trend in the surgical treatment

of diverticulitis reveal a steady shift to the more radical and curative operations. The 27 per cent mortality in 218 sigmoid resections at the Massachusetts General Hospital from 1942 to 1957 is impressive and their end results have been excellent. The place of one stage segmental resection as a mode of relief from diverticulitis of the colon is recommended in the carefully selected patient.

Jensen⁹¹ stated that diverticula are the principal source of massive hemorrhage from the colon. The anatomic basis for such hemorrhage is that the diverticula occur near the mesenteric border at the point at which the nutrient vessels penetrate the bowel. There is also an unusual vascularity in the walls of the diverticula. Some degree of erosion or inflammation must be present although no symptoms of such need be present. Usually arteriosclerosis and hypertension are accompaniments. Conservative treatment is recommended but if surgery is mandatory segmental resection of the most involved area is the procedure of choice.

Scarborough⁹² accumulated 89 patients with proven diagnosis of premalignant or malignant lesions who were observed for more than one year with a diagnosis of diverticulosis or diverticulitis as an accepted cause for their bleeding. He advised exploratory operation and colonoscopy when bleeding persists above the rectum and repeated roentgenograms show only diverticulosis.

Colcock¹⁰ noted from his analysis of 131 patients operated on during the past 10 years at the Lahey Clinic that in younger patients (less than 50 years of age) with recurrent attacks of diverticulitis complications necessitating surgical intervention were more likely to develop. Often some degree of complication was present when the patient arrived at surgery such as a partial obstruction and small abscesses between the colon and bladder or lateral abdominal wall. He found in this series that bleeding always responded to conservative management. The mortality rate in this group was 1.5 per cent. Of the 66 patients 69 were subjected to a one stage resection with a primary anastomosis with no mortality. He advocated earlier operation in these patients with relatively uncomplicated diverticulitis thereby lowering the mortality and shortening the hospital stay.

1959

Schlicke and Logan⁸ believed that surgery for diverticulitis is rare outside the sigmoid colon. In their series approximately 10 per cent of the patients were not considered preoperatively to have diverticulitis. The reasons for a faulty diagnosis were as follow:

(1) Diverticulitis frequently presents the clinical picture of gynecologic disease or carcinoma of the intestine. (2) when complicated by perforation diverticulitis may mimic diseases causing general peritonitis such as appendicitis. (3) there may be an absence of any accompanying change in bowel habit. (4) leukocytosis and fever may be absent. (5) the presence of gross bleeding suggests diseases other than diverticulitis. and (6) there is a discrepancy between the clinical picture of diverticulitis and the radiologic interpretation of diverticulosis without diverticulitis.

The indications for surgery in order of frequency are: (1) intractability of symptoms. (2) presence of palpable mass. (3) inability of the radiologist to exclude carcinoma. (4) bleeding. and (5) external fistula. They advocated one stage resection and anastomosis before serious complications develop necessitating multiple stage procedures.

Earley¹¹ reviewed the literature and found reports of 24 patients who were operated on to control hemorrhage from diverticular disease. Most of the patients were older than 60 years and most patients had operative procedures as emergency. Adding 7 patients of his own for a total of 31 patients brought the mortality to 29 per cent.

He advised conservative management first which is often adequate and then ruled out other causes for bleeding. Even then the bleeding may not be attributed to the diverticula. If diverticula are believed to be the source he then felt that one is compelled to resect all of the colon containing diverticula. If the patient is too ill to tolerate resection or colectomy proximal ileostomy or colostomy may be helpful.

Inglis and Hampson¹² favored the embryologic origin of the diverticulum in the cecum and a cecocolic colon. They believed it

is not always possible to distinguish diverticulitis in this location from acute appendicitis on a clinical basis but the suggestive triad described by Byrne, Kallan and Bassett¹⁷—(1) history of previous appendectomy (2) presence of a fecalith in the region of the cecum on x-ray study and (3) symptoms of inflammatory disease in the right lower abdominal quadrant—is helpful. At surgery 70 per cent of the diagnoses are correct and the remainder usually masquerade as carcinoma. Colotomy or cecotomy often provides the diagnosis in the questionable cases. They thought that major colonic resection can usually be avoided if diverticulitis is considered. The treatment of choice in this situation is local excision or simple inversion of the diverticulum.

3 *Diverticulosis*

PATHOGENESIS

The first observations by Friend in 1730 by Baille in 1794 and later by Cruveilhier Konjetzny and Klebs established the entity of the lesion the diverticulum. The subject then remained unnoticed in the literature at least until Graef in 1896 became interested in the pathogenesis having made the observation that the lesion was always found near the entrance of a blood vessel into the wall of the intestine and stating his belief that the herniation was associated with obstruction to the blood flow as in valvular heart disease. About the same time Hanau³ did some experimental work on human intestine at autopsy by filling the intestine with water and observing that rupture took place into the mesentery. In 1904 Beer questioned the theory that the weak spot through which herniation occurred was always on the mesenteric side in fact he stated definitely that herniation occurred because of a muscular deficiency on the nonmesenteric as well as the mesenteric side and it was his belief that old age and constipation were the causes of herniation—old age by degeneration and constipation by intraluminal pressure. In 1907 Mayo Wilson and Giffin added obesity to old age and constipation on the list of causes and left chronic passive congestion as a possibility. In 1911 Wilson attributed the lesion to congenital weakness of the circumferential muscularis and to pressure from chronic constipation. In 1954 Barborika and Texter stated their belief that neither obesity nor constipation plays a significant role in pathogenesis and again mentioned the fact that diverticula form where the intestinal wall is weakened by entry of blood vessels and that since the arteries of the mesentery divide into two branches and enter the intestine separately diverticula frequently occur in pairs at the edge of the lateral longitudinal bands. However they stated that while degenerative changes of advancing age predispose to herniation the final impetus to diverticular formation is still unrecognized.

is not always possible to distinguish diverticulitis in this location from acute appendicitis on a clinical basis but the suggestive triad described by Byrne, Kallan and Brissett¹⁷—(1) history of previous appendectomy (2) presence of a fecalith in the region of the cecum on x-ray study and (3) symptoms of inflammatory disease in the right lower abdominal quadrant—is helpful. At surgery, 70 per cent of the diagnoses are correct and the remainder usually majorly carcinoma. Colotomy or cecotomy often provides the diagnosis in the questionable cases. They thought that major colonic resections can usually be avoided if diverticulitis is considered. The treatment of choice in this situation is local excision or simple inversion of the diverticulum.

with all layers caused by traction of tumors or adherent organs and the false is produced by congenital weakness of the walls and excessive intraluminal pressure. Hartwell and Cecil however in 1910 found no useful purpose in the classification of true and false or congenital and acquired and Wilkinson in 1933 stated that this classification had no clinical value. Subsequent authors also seem willing to discard this classification.

Authors' Comments

With most writers of today the authors agree that the classification of true and false or congenital and acquired has only historical interest except in the case of so called traumatic diverticulitis of the cecum.

INCIDENCE AGE AND SEX

In 1930 Rankin and Brown stated that diverticulosis occurred in about 5 per cent of persons having abdominal symptoms and probably in 1 per cent of all persons. Ochsner and Bagen²³ in 1935 reported a 7 per cent incidence in 2,747 patients examined radiologically at the Mayo Clinic. Young and Young in 1944 reporting on 70,572 colons studied by autopsy or with barium x-ray examination gave the figure of 5.2 per cent for the incidence of diverticulosis.

Authors' Comments

It is impossible to estimate the incidence of diverticulosis with any degree of accuracy since usually the diagnosis is made roentgenologically and only a relatively small group of human beings have a barium enema examination or upper gastrointestinal series in which the passage of barium through the whole digestive tract is recorded by films. Autopsy reports may be used as supplemental sources but in general are less dependable than roentgenograms for this diagnosis.

It is interesting to note that Rankin and Brown's estimate of 5 per cent incidence of diverticulosis in patients with abdominal symptoms corresponds approximately with that of Young and Young, in

Authors' Comments

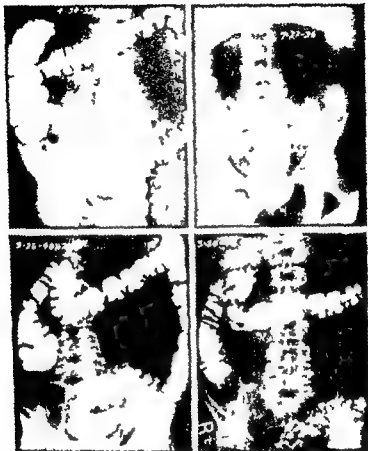
The authors agree with Barborika and Texter that there is as yet no proof of the exact nature of the final impetus for the formation of diverticula. They also believe that since diverticulosis is in general a condition first discovered in middle or old age the degenerative processes alone or in combination with the cumulative insult of procedures abusive to the colon or of abnormal influences upon the colonic musculature from psyche or soma most probably play a part in the formation of these herniated sacs.

Spasm the evil phenomenon at the root of many digestive complaints is undoubtedly present to produce the increased intraluminal pressure so generally agreed upon as a causative or precipitating factor. If this word *spasm* is substituted for the word *constipation* a word meaning many things to many people the authors suggest that the two factors present in the formation of a diverticulum are probably degenerative changes with a possible congenital background* producing weakness or a gap in the muscularis together with an abnormal degree and frequency of spastic contractions producing intraluminal pressure. Carlson and Hoelzel's investigative work on rats was of interest suggesting that fat infiltration weakened the bowel and that a diet which produced increased colonic pressure through continuous contraction caused diverticula. The latter observation has special interest for the authors.

TRUE AND FALSE DIVERTICULA

This distinction based on the finding of all layers of the intestinal wall in some cases and only the mucosa in others was of interest during earlier studies when the designation *true* was thought to be identical with *congenital* and *false* meant *acquired*. Mayo in 1907 considered acquired diverticula to be either true or false depending upon the number of layers of the intestinal wall the true variety

The theory of a congenital background is supported as frequently stated in the literature by the fact that diverticulosis does occasionally occur in the young. Interesting also in this regard is Schlotthauer's report of 7 cases in one family of 9 persons and the clinical observation made by the author and others that a familial diverticula is is frequently seen.



aged 65 have diverticula. This statement conforms with the impression of the authors.

Also it has come to be the opinion of most observers today that the sex incidence is about equal and the authors agree with that opinion. Hence based on estimate only 5 per cent of all individuals but 15 to 40 per cent of those over 40 have diverticula while in the really aged the intestinal muscularis apparently becomes weak enough to allow the development of diverticula in varying extent (FIGURES 1 and 2) in about two thirds of the population.

a large unsclerified group. When the specific age group of individuals over 40 is considered, the estimated incidence in the literature rises as high as 15 per cent to 10 per cent (see Johnson's Fig 276 in Bockus' Gastroenterology on age distribution from Millard and Bockus, 1936) and this incidence increases with each decade. Allen and Behringer (1956) stated that about two thirds of persons



FIG. 1.—Development of diverticula in patient with irritable colon *a* 1919 *b* 1931 and *c* 1938

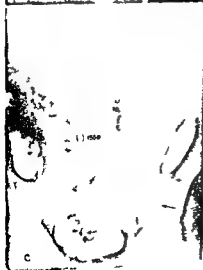


FIG. 2 (facing page).—Development of diverticula in patient with irritable colon *a* 1932 *b* 1934 *c* 1910 and *d* 1913



Fig. 4.—Diverticulosis of sigmoid with an associated giant diverticulum.

clinically interesting but harmless condition called by Case *diverticulosis*.

In 1927 Spriggs and Marxer²⁰ and in 1931 Barborika and Texter mentioned the saw-edge appearance of the sigmoid as indicating a prediverticular state and the fact that diverticulosis is often best visualized in the postevacuation film.

Authors' Comments

In the authors' experience colonic diverticula are best visualized in the postevacuation barium enema film or in a film taken 24 hours

DIAGNOSIS

X ray Study

It is generally agreed that diverticulosis cannot even be suspected clinically until the complication of inflammation and its sequelae occur. In 1915 however Case and Carman reported separately the early x ray observation of this condition. Following their report all radiologists looked for and found what they considered a



FIG. 3.—Extensive diverticulosis demonstrated after evacuation of barium.

diverticulitis stating that actually seeing the diverticula is possible more often than is usually believed. In 1951 Smith added another diagnostic point to Buie's statement with his observation that displacement of the fecal content of the sac under slight pressure from the distal tip of the sigmoidoscope helps to diagnose and localize diverticulosis.

Authors' Comments

In the experience of the authors and their colleagues the openings of the diverticular sacs are very rarely seen by proctosigmoidoscopy. Other signs are present when there is an inflammation or other complications. These will be discussed later.

TREATMENT

Authors' Comments

Most writers on the subject of diverticular disease regard treatment of the diverticula as entirely unnecessary until complications initiated by inflammation occur. They consider all diverticula of the digestive tract from the esophagus to the anus as innocuous unless inflammation is present.

In the authors' opinion this is usually true of diverticula of the upper digestive tract but in the colon where strong sometimes violent muscular contractions occur it is wise to use prophylactic treatment against the occurrence of diverticulitis. The authors' theory is that inflammation is usually initiated by the blocking of the openings into the diverticula by extreme and sustained muscular spasm so common in the irritable colon. It is therefore their belief that when symptoms of irritable colon are present and diverticula are visualized anywhere in the colon the patient should be advised that their presence is an additional reason for care of the irritable colon. Further discussion on this point will follow under the section on diverticulitis.

after the barium meal (FIGURES 3 and 4) The differentiation between polyps of the sigmoid and diverticula in that area some times becomes a problem and here lateral films postevacuation films and double contrast films are of help in differentiating diverticula from polyps (FIGURE 5) An inverted diverticulum protruding into the lumen of the intestine may strongly simulate a polyp



FIG. 5—Diverticulosis of sigmoid demonstrated after an air contrast study

The authors urge that in all reports of barium enema examinations the presence and location of diverticula should be reported as well as an estimate of their size and number Such reports have importance not only for evaluation of the patient's present or possible future abdominal symptoms but also in aiding statistical research studies

Proctoscopy

Buie in 1939 and Jackman and Buie in 1943 reported diagnostic signs by proctoscopy which aroused suspicion of diverticulosis or

tioned the tendency to recurrent attacks and the chronic inflammatory changes in the whole intestinal wall and its mesentery obstruction resulting from the factors or from adhesions. In 1930 Rankin and Brown considered diverticulitis to be the result of improper emptying of the bottle-shaped acculations with subsequent inflammatory reaction, necrosis, frequent tumefaction and occasional perforation. They described the local inflammatory changes in the mucous membrane of the diverticulum which undergoes atrophy and subsequent round cell infiltration of the submucosal coat and lateral ulceration. The changes progress both in the wall of the bowel and in the mesentery producing a pericolitis and mesenteritis. The changes in the coats of the diverticulum vary from attenuation of the musculature to its complete absence.

Authors' Comments

To the descriptions of the pathogenesis of diverticulitis cited above little new has been added in the last quarter of a century. The authors would like however to emphasize again the role of spasm in the development of inflammation in the diverticula. Morton in 1916 in his 196 reported cases divided them into two groups: diverticulitis with spasm and diverticulitis with complications. He together with Wilkinson in 1933 and Albright and Leonard in 1931 in their recommendations for treatment indicated that spasm plays an important role in the development of diverticulitis and that measures to relieve spasm and restore normal motility in the intestine are the best treatment for uncomplicated diverticulitis. The author's theory of the development of diverticulitis is that it is an advanced stage in the whole problem of pathogenesis of diverticulosis. The sacs have already been formed and with normal contractions of the bowel muscularis there is an inflow and outflow of fecal material which then passes on with the rest of the bowel contents. If however spasm in that area is excessive there is a tight closure of the diverticular openings and the phenomena of retained fecal material, inflammation, necrosis and ulceration may occur. More will be said on this subject when treatment of diverticulitis is discussed.

4 *Diverticulitis*

PATHOGENESIS

Moynihan in 1906 called attention to inflammatory tumors many of which were quite possibly due to the presence of false diverticula and associated inflammation. He was the first to point out a diagnostic difficulty which perplexes clinicians of today namely the mimicry by these tumors of malignant disease of the large intestine. Mayo in 1907 considered the true variety to be due usually to traction caused by adherent tumors or organs while the false were thought to be due to intraluminal pressure combined with a congenital weakness of the bowel. The inflamed diverticula might arise in his opinion from any surface and often extended into the epiploic appendages. He considered constipation with hardened feces impacted in the diverticulum as the cause for beginning irritation and ulceration. He thought old age and obesity were factors and he mentioned chronic passive congestion as a possible factor. He considered the inflammatory process either diverticulitis or peridiverticulitis the former causing no great reduction in the size of the bowel lumen but having a tendency to acute perforation into the peritoneal cavity. Peridiverticulitis on the other hand by producing chronic inflammation of the subserosa around the diverticula he considered more prone to cause obstruction and rarely to perforate because the reparative process was so predominant.

Telling in 1908 considered the pathologic factors of diverticulitis to be multiple and to include the narrow neck of the diverticulum, collections of fecal matter within the diverticula, constipation, increased intraluminal pressure and obesity. Hartwell and Cecil in 1910 considered the secondary changes occurring in diverticulitis to be comparable to those in the vermiform appendix in appendicitis the inflammatory process causing destruction of the coats of the wall with perforation leading into a localized abscess or generalized peritonitis or septicemia. They were among the first to describe fistula formation especially into the urinary bladder. They also men-

to find out what happened to the diverticuli in 294 patients (average age at time of diagnosis 55 years) over a course of years after they were diagnosed as simple diverticula. It was revealed that in 73 patients (25 per cent) diverticulitis developed but in 40 of these (more than 50 per cent) there was no second attack in a follow up period varying from one to 27 years. 19 of these 73 had follow up study for 11 to 27 years. In 33 of this 73 (45 per cent) multiple attacks occurred but of these 33 16 patients (slightly less than half) had only two attacks in a follow up of one to six years after the second attack while 17 patients (slightly more than half of this group with more than one attack and approximately 6 per cent of the total 294 patients) had more than two attacks of diverticulitis. This group under observation was also under management for irritable colon and although the control of mismanagement was not recorded the significance of these statistics (25 per cent having at least one attack of diverticulitis in a follow up of 15 years average) is probably greater than in any study without follow up. Of equal significance is the fact that under these conditions only 6 per cent of the total group had more than one attack during this follow up period.

DIAGNOSIS

The symptoms related to diverticuli are caused by spasm and inflammatory change which indicate that diverticulitis has occurred. The severity of the symptoms depends on the degree of involvement and the location of the inflammatory process. Pain is the cardinal symptom. It is usually located in the left lower quadrant of the abdomen and reflects involvement of the lower descending or sigmoid colon where the majority of diverticula occur. Depending on the degree of spasm and inflammation or the development of complications the pain may be of a dull aching character or more severe as occurs with acute appendicitis. Colic or cramp-like pain suggests severe spasm or some degree of obstruction. Constipation or tenesmus and diarrhea associated with anorexia, nausea and vomiting may be expected in severe acute attacks.

INCIDENCE

Mayo in 1917 10 years after his first paper on 'acquired diverticulitis' reported 42 cases in which operation had been performed 37 of which involved the sigmoid 1 the transverse colon 1 the ascending colon 1 the hepatic flexure and cecum Later writers began to estimate the percentage of diverticulitis among all patients with diverticulosis Rankin and Brown in 1930 stated that of the 5 per cent of patients with abdominal symptoms who had diverticulosis 17 per cent had diverticulitis In 1914 Young and Young from a compilation of statistics comprising 70 572 colons (x ray and autopsy cases) in which 5 per cent had diverticulosis 12 to 15 per cent of these had diverticulitis In three series of their compilation however totaling 3 915 cases of diverticulosis the incidence of diverticulitis was 34.3 per cent Wigh and Swenson in their paper in 1951 dealing with the roentgenologic aspects of diverticulitis and its complications stated that of the generally accepted 5 to 10 per cent incidence of diverticulosis diverticulitis developed in 12 to 22 per cent Barhorka and Texter (1951) stated that in their experience 5 to 10 per cent of all patients have diverticula and of this group diverticulitis develops in 15 to 20 per cent Greene⁵¹ in 1957 found 50.7 per cent diverticulitis in a review of 353 cases of diverticulosis The highest incidence of diverticulitis was reported by Allen and Behringer in 1956 in their paper on this condition in the very aged They stated that two thirds of persons aged 85 have diverticulosis and of this group one third have diverticulitis In the group of cases of diverticulosis studied for subsequent developments by Boles and Jordan diverticulitis developed in 73 of 291 patients (25 per cent) with diverticulosis at some time during a period of 10 to 17 years

Authors' Comments

As with statistics on all diseases there can be considerable confusion because of the variety of sources from which information is obtained In the paper by Boles and Jordan the specific purpose was

regional ileitis ulcerative colitis carcinoma bacillary and amebic dysentery and pelvic pathologic alterations in the female. Boles and Hodes¹ in describing a group of cases with endometriosis involving the small and large intestine and rectum recently showed how the disease can mimic diverticulitis in its varying forms.

Roentgen examination of the colon by means of the barium enema usually indicates the presence of diverticulitis both by revealing certain fairly specific changes and by eliminating other conditions mentioned in the differential diagnosis (FIGURES 6, 7 and 8).



Fig 7—Diverticulitis of sigmoid with partial obstruction and intraluminal symptoms



Fig 11—Uncomplicated diverticulitis of sigmoid

On physical examination the abdomen is frequently distended and tympanitic. Definite localized tenderness is noted over the site of the inflammatory process and either a painful segment of bowel or an inflammatory mass will usually be palpable. On occasion the inflamed segment of bowel is more easily defined by pelvic or rectal examination. Some degree of fever usually is present.

In the differential diagnosis one must consider acute appendicitis

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FIG. 7.—Diverticulitis of sigmoid with partial obstruction and intractable symptoms.



Fig. 6—Uncomplicated diverticulitis of sigmoid

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In the differential diagnosis one must consider acute appendicitis

Schatzki¹¹ stressed the following roentgenologic findings which he believes are of assistance in the diagnosis of diverticulitis (1) a long segment of bowel often involved (2) mucosa remaining intact (3) bizarre fringed contour (4) a associated spasm (5) tapered ends of the involved bowel and (6) accompanying diverticula in other segments of the bowel. In the absence of diverticulitis 24 and



FIG. 8—Diverticulitis of sigmoid

18 hour examination of the bowel following barium meal will reveal the presence of diverticula more clearly than will a barium enema.

Proctoscopy is of invaluable assistance in the differential diagnosis of diverticulitis. Following are five signs previously mentioned and emphasized by Baile¹² (1) relative immobility of the bowel in a segment which normally is freely movable (2) angulation of the lumen of the bowel (3) reduced lumen and mucosal fold (4) sigmoidal sacculations distinguished from spastic contracture of the bowel in that they do not disappear with inflation and (5) actual visualization of the diverticula more frequently seen with

diverticulosis than with diverticulitis. He cautioned that the rare everted diverticulum which can strongly resemble a polyp should be identified. If such an error is made and fulguration is attempted perforation is an unfortunate sequela.

Authors' Comments

In the majority of patients the exact precipitating cause of acute diverticulitis cannot be determined. Specific inquiry, however, will frequently reveal that fatigue, sustained nervous tension, dietary or alcoholic excesses and indiscretion or an upper respiratory infection have usually preceded an attack. The frequent indiscriminate use of laxatives in preparation for diagnostic studies or in bowel preparation for a proctoscopy or barium enema is an avoidable contributing factor in converting a quiescent colon with diverticula into diverticulitis.

Not infrequently patients with an irritable colon and diverticulosis who are suffering an aggravation of their symptoms are classified as having an attack of diverticulitis without any of the accompanying features found by physical examination, laboratory findings or roentgenologic study. Errors in over diagnosis or under diagnosis are made in this group and can lead to mismanagement and to unfortunate variations in statistical reporting.

In radiographic study during an acute attack, particularly when a small segment of bowel or perhaps only a single diverticulum is involved in the inflammatory process, diverticula may not be visualized and spasm may be the only finding.

We have seldom received significant assistance from examination—grossly or microscopically—of the actual rectal discharge or stool. When blood or pus is seen, our search is intensified to rule out carcinoma.

Attempts to demonstrate tumor cells by means of cytologic examinations of the specimens from the bowel with the techniques now recommended in acutely ill patients have been found to be neither practical nor dependable.

COMPLICATIONS

Carcinoma and Diverticulitis

The first complicating aspect of diverticulitis mentioned in the literature is one which for the clinician of today is still a perplexing problem. It was mentioned by Moynihan in 1906 in the 6 cases which he reported as having inflammatory tumors of the large intestine presenting all the clinical appearances of cancer which proved on pathologic examination to have been wrongly diagnosed. Graef also described this problem in 1899. In 1910 it was suggested by Hartwell and Cecil that a carcinoma superimposed upon diverticulitis might develop and in 1911 Wilson proposed that low grade proliferative changes took place in the tips of the diverticula to form segregated epithelium parallel in all respects with cell changes which occur in masses of epithelium segregated about the base of a gastric ulcer. From this development the entire diverticulum became involved, the walls infiltrated with a histologic picture which must be diagnosed as carcinoma. A year later (1912) McGrath stated that cancer was associated with diverticulitis in 25 per cent of his series of cases. Case in 1915 mentioned the difficulty in differentiating diverticulitis from carcinoma. In 1917 Mayo stated that carcinoma coexisted in 13 (31 per cent) of 42 patients with diverticulitis upon whom he had operated. He considered this more than mere coincidence and was of the opinion that chronic irritation and inflammation led eventually to a cancerous change. In 1924 however Judd and Pollock while stating that the relationship of carcinoma to diverticulitis was not determined, noted that Mayo's evidence taken from a study of 137 cases suggested that there was no relationship between the two conditions. The authors were the first to suggest that the relationship between diverticulitis and carcinoma was coincidental. In 1930 Rankin and Brown in a review of 227 cases had only 4 cases in which malignant disease was associated with diverticulitis and in 679 cases of carcinoma of the colon only 4 cases of diverticulosis were present. Wilkinson in 1933 mentioned the difficulty of differentiating the two conditions both clinically and roentgenologically. Morton in 1916 in his series of 196

cases stated that 17 patients had carcinoma associated with diverticulosis but called attention to the important fact that in only 4 of these patients the carcinoma was in the area of the colon involved by diverticulitis. In 1951 Wigh and Swenson in their paper on radiologic aspects of diverticular disease stated that evidence of spasm and edema was rarer in carcinoma than in diverticulitis. In 1952 Rowe and Kollmar in discussing diverticulitis complicated by carcinoma stated that obstruction and anemia are more suggestive of carcinoma whereas evidence of inflammation a palpable mass and fistula formation are more frequent with diverticulitis. They quoted statistics from several hospitals showing that in 700 patients with carcinoma of the colon only 7 had coexisting diverticulitis and carcinoma and of these only 3 patients (0.43 per cent) had diverticulitis and carcinoma in the same segment. Starkloff and Bindenthal mentioned in 1953 that the symptoms and signs of carcinoma and diverticulitis mimicked each other and also coexisted with symptoms suggesting only one entity. In their review of 250 patients with carcinoma of the bowel and 30 patients with diverticulitis 25 had coexisting carcinoma and diverticulosis 6 had coexisting carcinoma and diverticulitis but again the point was made that only 4 of these had carcinoma and diverticulitis of the same segment the rectosigmoid an incidence of 1.5 per cent suggesting that the relationship was coincidental. Twenty-five patients had carcinoma and diverticulosis of the same segment the rectosigmoid. They believed bleeding and cachexia should arouse suspicion of carcinoma and in their series bleeding was present in 62 per cent of carcinoma and 19 per cent of diverticulitis. The best differential x-ray sign for carcinoma was in their opinion a normal appearance of the colon above and below the malignant growth but this sign also had pitfalls. They emphasized the need for a more aggressive surgical approach to the treatment of all patients in whom cancer is strongly suspected. In 1954 Hoar and Bernhard stated that in 385 cases diagnosed as diverticulitis or diverticulosis only 14 patients (3.6 per cent) had carcinoma present in an area where diverticula were present and of 466 cases of carcinoma of the colon and rectum 38 (8 per cent) had a concomitant diagnosis of diver

ticulosis which they stated was the expected figure in the middle aged or older population as a whole. In 1954 Barborka and Texter stated that coexistence of carcinoma of the colon and diverticulitis was relatively rare that cachexia and rectal bleeding were more common in carcinoma while recurrent attacks of pain in the left lower quadrant fever constipation and urinary symptoms were more common in diverticulitis. Hanom in 1954 found that in operating on 53 patients with diverticulitis carcinoma was coexistent in 7. In 1956 Mayo and Delaney reviewed 50 patients (35 males and 15 females) from the ages of 11 to 82 who had diverticulitis and carcinoma of the colon simultaneously and who had had surgical treatment. In 38 cases (76 per cent) the preoperative diagnosis or impression had been correctly surmised.

Boles and Jordan in 1958 found 15 patients (5 per cent) of the 294 patients with diverticulosis who had cancer of the colon. Of the 221 patients with no progression to diverticulitis cancer developed in 8 (3.6 per cent). Of the 73 patients in whom diverticulitis developed during their observation period cancer developed in 7 (9.6 per cent). This apparently significant relationship however was invalidated by the fact that in 2 of the 7 patients cancer developed in an area uninvolved by diverticulitis and in 2 others the carcinomas were in polyps which were detected in a period when there was no active diverticulitis. This leaves only 3 cases or 4 per cent of the patients with diverticulitis in whom there could possibly be a presumptive relationship.

Authors Comments

From the year 1951 on emphasis was placed by several writers on the necessity for surgery in all cases in which carcinoma could not be ruled out but the impression persists that this is not always feasible. A persistent mass or an x-ray deformity is usually the equivocal point.

There is no question but that a mass or x-ray deformity of any segment of the colon must be viewed with grave suspicion of cancer and the problem of early differential diagnosis of carcinoma from diverticular disease is more difficult because diverticulitis occurs

most often in that period of life when carcinoma is likewise most frequently found. When the lesion is in the left lower quadrant where both carcinoma and diverticulitis are so often found the differential diagnosis is especially difficult because of the immobility of the mass and its inaccessibility to sigmoidoscopic examination.

In these days when surgery is relatively safe it is imprudent to wait for cachexia to arouse suspicion. Dependence must therefore be placed to some degree upon the history, to a large degree upon x-ray findings, and to a very minor degree upon statistics indicating the coexistence of diverticulitis and carcinoma and the possibility of considering diverticulitis as a precursor of carcinoma. As has been so often and in the literature a history of recurrent attacks of pain in the left lower quadrant, usually with fever and leukocytosis, and the findings of x-ray evidence of diverticula are the diagnostic criteria for diverticulitis. When the lumen of the bowel is narrowed as shown by x-ray findings and there is clinical evidence of obstruction and if a mass is palpable carcinoma is suspected and cannot be definitely ruled out without surgical resection and histologic examination. There are however factors which influence one's judgment in one direction or another. Statistical evidence has seemed to disprove Wilson's theory that the epithelial proliferative changes of diverticulitis lead to carcinoma. It must therefore be a question of deciding whether or not the lesion in question is carcinoma coexistent with diverticulitis or simple diverticulitis. The precachectic evidence suspicious for carcinoma has been thought by many writers to be both bleeding and x-ray signs but in the opinion of the authors x-ray findings alone are the only suggestive evidence. The complication of bleeding will be discussed separately but its occurrence in diverticulosis and diverticulitis is a definite entity and is not necessarily a reason for suspecting carcinoma. The x-ray evidence consists of the following factors—an area of narrowed lumen with obliterated mucosal pattern and shelflike superior and inferior borders separating normal bowel from the involved area (FIGURE 9). This is in contrast to a more gradual change from normal bowel to the inflamed segment of diverticulitis in which perhaps edematous

but otherwise normal mucosa can be visualized. It must always be recognized, however, that the signs of cancer can be obscured by the deformities produced by the presence of multiple diverticula and of diverticulitis. With persistent or increasing stenosis uninflected by a short period of conservative management the diagnosis must usually be determined by resection and then the only problem for the surgeon is the decision as to the extent of the resection.

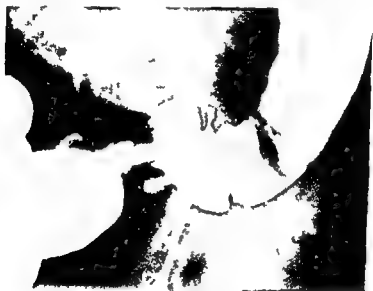


Fig 9—Carcinoma of sigmoid with associated diverticula

Without obvious signs of carcinoma this decision must be made on biopsy and frozen section examination and an appropriate operation performed.

Bleeding

In the earlier days of studies of diverticular disease there was considerable reluctance to the acceptance of bleeding as a symptom of diverticulosis or diverticulitis without an associated polyp or malignant condition. However Rankin and Brown in 1930 stated that when bleeding occurs as a symptom of uncomplicated diverticu-

itis or diverticulosis an associated malignant condition is always suspected but frequently not found

For some years now the concept has been well established that hemorrhage may be an outstanding and often perplexing symptom of both diverticulosis and diverticulitis. While this is true anal bleeding without hematemesis still remains a problem worthy of special consideration.

The frequent difficulty in identifying the source of such bleeding is emphasized throughout the literature and the exhortation prevails that before assuming that such bleeding has its source in a diverticulum all other areas in the gastrointestinal tract be carefully examined by proctosigmoidoscopy radiologic examination study of clotting mechanisms and liver function studies. Almost all writers on this subject have urged that careful search must be made for hemorrhoids ulcerative colitis polyps and carcinoma.

The incidence of bleeding in diverticular disease has been variously estimated as from 5 to 8 per cent in diverticulosis and from 15 to 25 per cent in diverticulitis. Smithwick¹⁰ in 1942 reported bleeding in 15.7 per cent of 568 cases of diverticulitis from the Massachusetts General Hospital and the literature. Young and Young in 1944 estimated that bleeding usually minor had been thought to occur in 5 to 17 per cent of diverticulitis and was more often found in the chronic than in the acute phase of this disease.

Judd and Mears in 1935 found an incidence of hemorrhage of 8.5 per cent in a series of 68 cases of diverticulitis. Bell¹¹ in 1953 reported that in 68 patients with diverticulosis or diverticulitis which required operation 50 per cent had blood in the stools but of these 64 patients 28 per cent had carcinoma and 10 per cent colonic polyps. Knight in 1937 reported 12.4 per cent of gross bleeding in 185 patients with diverticulosis or diverticulitis and considered it to be more frequently found in diverticulosis than in diverticulitis. Boles and Jordan in 1938 found in their follow up study of 294 cases that during the years of observation (average 15 years) under more or less strict treatment 16 patients (5.4 per cent) had bleeding and of these 16 patients 7 had diverticulitis.

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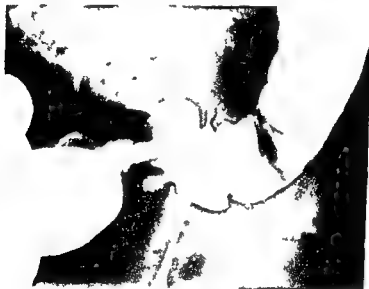


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But the strong suspicion of cancer when bleeding is present has persisted as is evidenced by the paper of Gilchrist and Economou in 1955 who advocated operation for diverticulitis when bleeding occurs because it must then be assumed that polyps or carcinoma are also present. In 1956 Waugh and Walt while claiming that in about four fifths of patients with diverticulitis surgery could be avoided if medical management were employed stated that otherwise unexplained melena with x ray evidence of diverticulitis is one of the indications for surgery. Repeated bleeding had also been mentioned by Swinton in 1951 as an indication for surgical intervention. In fact this type of continued even if intermittent blood loss when otherwise unexplained and if persistent under medical management has become an accepted indication for resection of the area where diverticula are visualized even though carcinoma is not seriously suspected. When no doubt of cancer exists in the diagnosis Mobley Dockerty and Waugh⁷² in 1957 reporting on 31 patients who had had surgical treatment for diverticulitis associated with bleeding stated that conservative treatment was possible in many instances.

Keith and Rini in 1957 mentioned the reluctance of clinicians and pathologists to accept diverticula as a source of hemorrhage because a bleeding point may be difficult to find at autopsy. Pfeiffer⁸⁶ in 1944 in a discussion of a paper by Stone¹⁰¹ on melena of unknown origin explained the absence of external evidence of the site of bleeding from a diverticulum on the basis of the contiguous location of the diverticulum to the artery which feeds the epiploic appendage.

While bleeding from diverticular disease is generally reported as minor bleeding usually intermittently observed the occurrence of massive hemorrhage from diverticular disease has also been reported in recent years. Hickey in 1954 reported a case of massive exsanguinating bleeding in a 65 year old man in whom surgery revealed a perforation of an area of sigmoid diverticulitis which had involved the left inferior epigastric artery with a fistulous tract

carrying the blood into the colon. Also in 1951 Hoar and Bernhard reported 4 cases of massive hemorrhage in patients with diverticular disease. In certain of such cases it may become necessary to explore surgically even without completed investigation of the source of bleeding. The surgeon may then be confronted with a colon filled with blood and with numerous diverticula scattered throughout the extent of the bowel. While some of this blood may be the result of backflow from a distal artery it cannot be assumed that the source of bleeding is in the sigmoid especially since cases of massive hemorrhage from diverticula in other areas have also been reported. A case of multiple diverticula of the cecum and colon with clotted blood in numerous diverticula at emergency operation was reported by Cate² in 1953. Hoar and Bernhard reported 2 patients with diverticulitis who presented the problem of uncontrolled rectal hemorrhage requiring exploration as a life-saving measure and 4 other patients with diverticular disease with massive hemorrhage 3 of whom died. Knight in 1957 reported massive bleeding from extensive diverticulosis and in 1 case the source of bleeding from the mouth of a diverticulum was seen on proctoscopic examination. Mobley, Dockerty and Waugh reported a patient with diverticulitis in whom death from myocardial infarction followed two weeks after massive rectal bleeding.

Authors' Comments

The reluctance of earlier writers to accept bleeding as a symptom of uncomplicated diverticulosis or diverticulitis has been changed by experience to a recognition that this symptom may occur with both the conditions. Bleeding is usually of minor degree and intermittent but massive hemorrhage has also been reported often enough to establish it as a possible occurrence in this disease. Minor hemorrhage is usually described by the patient as bright blood on the surface of the stool and mucus may or may not be seen mixed with the blood. From the first reporting of bleeding as a symptom of diverticular disease up to the present great emphasis has been placed in the literature on the need for careful examination of the anal canal, rectum and sigmoid for the presence of hemor-

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tom⁵ Patten^{64 65} noted in his study of 131 cases of diverticulitis that infection of the pelvic colon is well tolerated and many of the patients consulted their physicians only after the fulminant signs of generalized peritonitis appeared.

The first report of a perforated diverticulum with diffuse peritonitis was made from an autopsy described by Fiedler⁴⁴ in 1868. In recent years there have been frequent reports of unusual



Fig. 10—Diverticulitis of sigmoid with localized perforation.

cases often in sigmoid diverticulitis but occasionally in diverticulitis of other areas of the colon for example in the report of cecal diverticulitis by Case and Shea in 1953.

Morton in 1916 reported 39 perforations in 111 cases of diverticulitis, 3 of which were free into the peritoneal cavity, the other 36 forming a localized abscess. Of these 10 died while in the hospital. Fistula developed in 22 cases and more than one region was involved in 11 cases—11 to the skin, 8 to the bladder, 2 to the urethra, 2 to the small intestine, 1 to the cecum, 2 to the rectum, 1 to the vagina, 1 to the retroperitoneal tissue, 1 forming an ischiorectal sinus and 1 into the mesocolon. Kraemer and Siegel⁶⁷

roids, polyps or carcinoma. Physicians today are keenly aware of this need for thorough investigation. The detection of sigmoid polyps in the presence of diverticulosis is often difficult even with air contrast enemas. Lateral projections are helpful in differentiating polyps from diverticula although rarely a diverticulum inverted into the lumen of the bowel may be mistaken for a polyp.

Carcinoma must always be suspected when rectal bleeding occurs but in the absence of sigmoidoscopic and x-ray findings positive for cancer, polyps or other intestinal lesions, diverticula if present may properly be suspected. The most recent trend of thought and one which conforms also with the authors' experience is that bleeding usually minimal but occasionally massive may occur from diverticula without the presence of inflammation and infection which produces diverticulitis. Perhaps the most innocent type of bleeding is the intermittent type while that due to carcinoma or polyp is usually persistent in spite of treatment. Apparently the intermittent bleeding caused by diverticula has its source in an erosion within the diverticulum which may heal with conservative treatment.

Bleeding which is persistent in spite of treatment is one of the indications for surgical treatment, first because of the effect of blood loss and second because under these conditions an ulcerative carcinoma cannot be satisfactorily ruled out in spite of negative examinations. The importance of repeated examinations is as great in this disease as in suspected cancer elsewhere in the digestive tract.

Perforation and Fistula

Perforation and fistula formation are the two most hazardous complications of diverticulitis. Peridiverticulitis with or without abscess formation or generalized peritonitis is usually present when perforation occurs (FIGURES 10 and 11). Abscesses may be small and entirely peridiverticular or larger and encapsulated in the mesentery.

Peridiverticulitis usually causes stenosis of the bowel lumen and in such cases differentiation from carcinoma may be impossible even at operation. Perforation may be acute and symptomatically of sudden onset or develop slowly with gradually progressive symp-

urinary symptoms indicating the presence of the severe complication of colovesical fistula.

The colovesical fistula is of course relatively common because of the anatomical proximity of bladder and sigmoid (FIGURE 12). It may be diagnosed either by the barium enema examination or by cystoscopy. In a recent case seen by the authors the diagnosis was made by the cystoscopic finding of a piece of lettuce in the bladder.

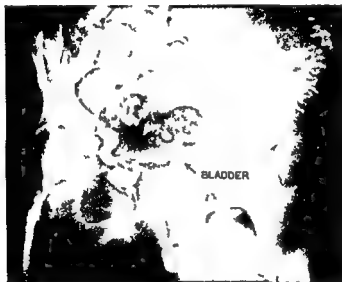


Fig 12—Diverticulitis of sigmoid with formation of a fistula to bladder.

of a woman who complained of bladder symptoms. In all cases, but especially in males, when urinary symptoms occur with an attack of diverticulitis, a colovesical fistula should be seriously considered.

Mayo and Blunt⁷³ in 1950 reported an incidence of vesico-sigmoidal fistulas in 46 (22 per cent) of 202 cases of proved diverticulitis of the large intestine. The sex incidence was 39 males and 7 females; the explanation was offered again that the interposition of the uterus between bladder and sigmoid usually protects the female from this complication. Urgency and frequency were noted by them also as the chief symptom and many of their cases

in 1918 reported a case of diverticulitis of the ascending colon with perforation abscess formation and fistulization into loops of the ileum

These problems of perforation and fistula formation involving surgery became less common with the advent of the antibiotic era as was noted by Friesen and Schmidt in 1955 the chief surgical problem now being a stenosing obstruction It is still true however that often the symptom of which the patient is first aware are



Fig 11.—Diverticulitis of sigmoid Multiple perforations with abscess formation

which surgical drainage is required. In recent years diffuse peritonitis rarely occurs from an acute perforation.

Urgency and frequency of urination often occur in cases of diverticulosis and the irritable colon syndrome and the symptoms *per se* do not indicate an impending or actual vesicocolic fistula although they are suggestive. Fecaluria and pneumaturia are pathognomic.

When this complication occurs a multiple stage procedure is required frequently with a greater mortality and morbidity which offers a rational argument for earlier operation in those patients who have recurrent attacks of diverticulitis at relatively short intervals. In the series of 69 patients of Colcock undergoing one stage procedures however some patients had a small vesicocolic fistula and others had localized perforations with small abscesses and a primary anastomosis was carried out with very little additional risk.

Obstruction

The complication of obstruction is usually the result of previous attacks of acute or subacute diverticulitis with progressive involvement of the bowel wall.

Mayo et al. in 1907 believed that peridiverticulitis with inflammation of the submucosa around the diverticula reduced the lumen of the bowel with resultant obstruction. In 1917 Mayo warned of the difficulty in distinguishing those patients with obstructive diverticulitis from carcinoma—the former often having a long history of symptoms of diverticulitis. Carcinoma not infrequently became manifest with a complete obstruction.

Morton in 1946 discussed 34 patients with diverticulitis with obstruction and related the significance of the history of repeated infections, scarring and thickening of the colon causing partial obstruction. Other possible causes for obstruction were adhesions about an abscess and the adherence of the small intestine to an area of colonic diverticulitis.

In 1951 Wigh and Swenson estimated that in two thirds of the patients with diverticulitis the symptoms were based on some degree of obstruction. They mentioned the practical point that with a

had been treated for urinary infection since there had been few symptoms suggestive of intestinal disease. Pneumaturia was present in 10 of the 46 patients and 14 complained of suprapubic or perineal pain. Of the 46 patients 21 had passed feces from the urethra and 10 had hematuria. The authors ascribed pain to inflammation and engorgement of the fistulous tract with the solid material of the feces. Gross hematuria was late in appearance and thought to be caused by trauma from fecal material and cystitis. The procedures used by these authors were as follows: (1) proctoscopy and sigmoidoscopy which showed changes suggestive of a fistula in only 3 of 38 patients; (2) barium enema examination which showed the fistula in 9 of the 45 patients thus examined, and (3) cystoscopy which revealed evidence of a fistulous opening in the bladder in 28 of 33 patients. The authors' experience with the use of organic dyes administered orally or rectally or instilled into the bladder to detect a fistulous communication was often misleading.

Authors' Comments

The complication of perforation and fistula in our experience is frequently associated with recurrent attacks of diverticulitis and predisposes to surgical intervention. In the paper by Boles and Jordan this complication occurred in 5 per cent of 294 patients who had follow up studies for an average of 15 years. With multiple attacks of diverticulitis the incidence of this complication increased because of a smoldering of the inflammatory process and the presence of small abscesses with incorporation of the adjacent tissue. The stage is thus set for fistula formation into the small intestine, bladder, vagina, uterus, rectum and perianal region and skin. It is sometimes difficult to determine whether a localized perforation with abscess formation has taken place with the masking of symptoms by the dampening effect of the surrounding structures walling off the perforation and the oftentimes rapid response to conservative management and antibiotics. Uncomplicated acute diverticulitis can mimic a small perforation in every respect. Although this complication occurs frequently it is impossible to know the number of cases in which spontaneous resolution occurs as against the number in



Fig 11—Aden carcinoma of sigmoid

obstruction to be infrequent in patients who had only one attack of diverticulitis but it was the most frequent complication when multiple attacks occurred and required surgery in 8 of 11 patients (73 per cent). The acute form in our experience is less common and it is more difficult to identify the cause preoperatively because of the inability to study the patient as carefully roentgenographically. In the patient who responds to conservative manage-

barium enema spasm produces a picture of a more severe grade of obstruction than is demonstrated when the barium passed distally. Hickey in 1954 believed that obstruction was the most common complication of diverticulitis which is the experience of most students of this disease in the more current literature.

Authors Comments

With multiple attacks of diverticulitis obstruction in some form becomes the most frequently observed complication and is an outstanding indication for surgical intervention. The authors found

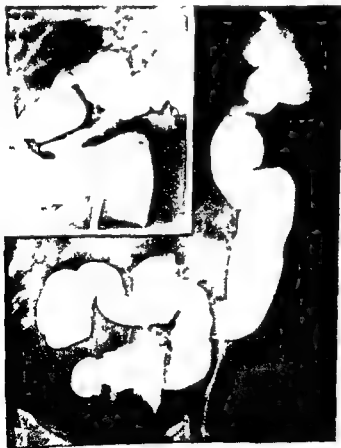


FIG. 13—Diverticulitis of sigmoid with intractable symptom

The ever present challenge of differentiating the pathologic process from carcinoma is most dramatically portrayed here and the surgeon often cannot make this differentiation with any degree of certainty by gross inspection of the intact bowel (FIGURES 13, 14 and 15). The bowel wall, adjacent tissue and mesentery are involved with the chronic inflammatory hyperplastic process which to the inspecting finger is a thickened hard mass with marked narrowing of the lumen.

When the specimen is inspected soon after removal the normalcy of the mucosa is striking in contrast to the far advanced pathologic changes of the extraluminal tissue.

Whereas a multiple stage procedure with colostomy preceding resection may be indicated in cases of acute obstruction, chronic obstruction can usually be managed safely with segmental resection and primary end-to-end anastomosis.

MEDICAL TREATMENT

In cases of acute, apparently uncomplicated diverticulitis the first and paramount principle is to put the bowel at rest. If possible the patient should be hospitalized. Bed rest and a low residue, warm, bland diet are essential. The application of heat to the abdomen, administration of hot water by mouth and antispasmodics (such as some form of atropine) in moderate, tolerated doses, provided the patient does not have glaucoma and mild edema, complete the initial phase. Paregoric or deodorized tincture of opium may be required to alleviate troublesome spasm and diarrhea. If the patient is afebrile and the acute symptoms subside in the first 24 hours, antibiotics are seldom indicated. With persistence of a low grade fever, leukocytosis and clinical evidence of continued activity, sulfasuxidine, azulfidine (amino azo sulfapyridine) or neomycin rather than the broad spectrum antibiotics will be found helpful. As a matter of fact, azulfidine often will be useful as a prophylactic in warding off a threatened acute attack. In the presence of vomiting, penicillin and streptomycin may be indicated as well as the parenteral use of fluids for 24 to 48 hours. The majority of patients will respond to these measures without subsequent complica-

ment with or without decompression of the bowel definitive study can then be carried out for diagnosis. Chronic obstruction resulting from diverticulitis with or without acute symptoms is due to the inflammatory process with edema, induration, fibrosis and narrowing of the lumen. Adhesions may involve the small intestine producing elements of both small and large bowel obstruction. Angulation by adhesions and inflammation may be most significant in contributing to the irreversibility of the clinical and pathologic picture.



Fig 15—Diverticulitis of sigmoid with narrowing and partial obstruction

development of chronic diverticulitis or complications requiring surgical intervention may be averted.

When attacks recur or complications such as perforation, fistula formation, obstruction or hemorrhage develop, surgical intervention becomes necessary. The trend is toward earlier surgery, but the decision requires the utmost in clinical judgment, and often the indications are not clear-cut. We would include as an indication for surgery the intractable form of clinical diverticulitis manifested by frequent recurrences despite good medical management.

Palliative treatment in those patients without complications, however, is still strongly supported by the authors. The opinion expressed that radical treatment is more logical in the young than in the old, since one of the serious complications is more likely to develop during the longer life of the younger patient, is not supported by the authors because it does not consider the possibility that diverticula are especially common later in life. Furthermore, in younger individuals, diverticula are quite likely to occur at some future time in other areas of the bowel in which case further surgical intervention might be required.

In our experience, the diagnosis of carcinoma is seldom as confusing as the literature indicates. Roentgenograms after a suitable period of intensive medical hospital management, stool examination for occult blood, and the utilization of the patient's clinical gastrointestinal history lend many helpful hints. A preoperative diagnosis of diverticulitis with hemorrhage has rarely been an indication for surgery. In such cases, distinguishing the condition from carcinoma becomes more pressing.

When surgical intervention is indicated, segmental resection is preferred because of the low mortality rate and the favorable long-range prognosis.

Colcock²⁰ stressed the fact that inadequate surgery is responsible for many of the complications associated with the surgical treatment of diverticulitis. Welch¹¹⁴ emphasized the need of discretion in the selection of patients for the one-stage procedure, and as a safety factor preliminary to the operation, he pointed out the value

tions or chronicity developing. The diet is then increased permitting only those foods that are easily digestible. The following program of management for an irritable colon and diverticulosis is then instituted.

The treatment of the irritable colon is all based on the principle of physiologic rest. Hypermotility of the small intestine and spasm of the colon respond to the various measures conducive to rest. For those patients in whom the symptoms persist under ambulatory dietary control or for those who are convalescing from an attack of diverticulitis, absolute bed rest is recommended. Heat (hot water bottle, electric pad or flaxseed poultice) is applied to the abdomen for one hour two or three times daily. The diet consists at first of the most easily digested bland foods served in six feedings during the day as the patient becomes asymptomatic the variety is increased to include meat, cooked vegetables and fruit and the meal frequency is returned to the conventional pattern with the heavy meal preferably at noon. No ice cold food or drink is permitted and supplementary hot water is given between feedings at regular intervals. Excluded from the diet are pork and pork products, veal and boiled meats, also excluded are raw vegetables and fruits. Food from the frying pan or cooked in deep fat and accessory foods such as nuts, candies, olives and pickles are forbidden.

Laxatives and lubricants are to be avoided at all times. The use of orange or prune juice diluted with equal parts of hot water before breakfast and for some patients before each meal is often an adequate stimulus for bowel function. Rectal injection of 3 ounces of warm mineral oil at bedtime or as an emergency procedure a saline enema may be permitted.

Smoking even when not excessive is in the opinion of the authors conducive to spasm of the colon. Alcohol may be used before the evening meal in the form of 1 ounce of whiskey diluted with 3 to 4 ounces of water without ice. Cocktails and dry wines are often troublesome. Adequate daily rest, exercise and regular vacations are encouraged to balance the patient's work schedule. In this way recurrent attacks of acute diverticulitis may be prevented and the

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of a protecting colostomy Bue¹⁵ likewise cautioned that in the more serious and complicated cases a preliminary colostomy should be performed

Whenever possible the operative procedure should be performed after the acute attack has subsided This is desirable both from the standpoint of morbidity and to permit a more direct and simple surgical approach

In the study of any patient with a history of diverticulitis or during the acute attack a search should be made for coexistent disease which may influence the prognosis with regard to subsequent attacks In our experience gallstones and peptic ulcer occur with sufficient frequency so that they should be considered and if present actively treated When gallstones are present cholecystectomy is indicated after the acute attack of diverticulitis has subsided

Prognosis

The prognosis for patients with uncomplicated diverticulitis on a bowel management program is quite good In the authors experience with 73 patients who had had diverticulitis more than one half (40 patients) had only one attack during a follow up period of one to 27 years In 19 of these the follow up period was 11 to 27 years As would be expected multiple attacks of diverticulitis were associated with more than twice as many complications as were single attacks 21 of the 33 patients who had been having multiple attacks were free of attacks during a follow up period of three to 10 years which can be partially attributed to the fact they had adhered to their program of bowel management

Depending on the type of complication and the surgical procedure used the prognosis may be extremely variable In well selected patients however who receive adequate surgery the prognosis should be quite favorable Following operation the patient is strongly advised to adhere indefinitely to the modified bowel management previously outlined in order to remain in a symptom free state

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